

Railway Mechanical Engineer

Volume 93

January, 1919

No. 1

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The Contents of Our January Issue

The publication of this issue of the *Railway Mechanical Engineer* was delayed for the purpose of giving our readers, as best we might, a review of the happenings in the mechanical department field for the year. The past year has been one of the most interesting in railroad history. Last year at this time the locomotive and car equipment on the railroads of this country was in very poor shape because of the extreme cold weather; the labor situation was extremely critical and large numbers of railway men had gone to France to do their part in relieving the transportation situation there. In this issue we publish a brief story of what was accomplished in France in the matter of handling the cars and locomotives under the jurisdiction of American railway forces. We give also a review of the labor situation and show what has been accomplished in improving the condition of cars and locomotives, together with the number of new cars and locomotives ordered during the year. In addition to this, the January *Railway Mechanical Engineer* contains a very complete article on the West Burlington shops of the Chicago, Burlington & Quincy, which represent, perhaps, the latest practices in railway shop construction.

Supervising Foremen Receive Increases

The compensation for the supervising forces in the mechanical department of the railways has at last been revised and as a general rule when these new rates are compared with what the workmen receive for an eight-hour day, they appear to be satisfactory. Contrary to the manner in which the increases in the workmen's wages was handled, this matter was handled by the regions or districts in which the roads were located rather than by establishing universal rates the country over. The latter method would be quite difficult to handle and have everyone satisfied, as the responsibility and effort required of foremen carrying the same titles vary on different roads. So far as we have been able to learn, however, the rates are sufficiently

high to make the positions attractive to competent men. By making a study of the increases which have come to our attention it is found that they are based on a 10-hour day with time and a half over eight hours. This, of course, is a very fair way of approaching the determination of a proper rate, as very few supervising foremen can get through the week without spending many more hours on the job than are required of the workmen.

With the disposition of the Railroad Administration to limit all classes of wage earners to an eight-hour day there will be but little of the dissatisfaction which existed a few months ago when the men were receiving so much overtime, caused by the small differences between the earnings of the wage earners and the supervising forces. It is to be hoped that with this added incentive and with the knowledge that the Railroad Administration is out after a full day's work for a full day's pay, as indicated by Mr. De Guire's address, published in last month's issue, the output and the discipline in the railway shops will improve. The task ahead of the foremen is a difficult one. Had these men been granted their increases along with those granted the workmen last summer the feeling of disrespect and disregard of the foreman's authority would have been prevented to a large extent. It would have been possible to hold some of the competent foremen who found it to their advantage financially to return to the ranks and to have attracted able organizers and leaders of men to the supervising positions. While it will be acknowledged generally that it was a short-sighted policy to follow, the mistake must not be allowed to interfere with a courageous and conscientious policy on the part of the foremen. Any tendency toward Bolshevism and insubordination should not be tolerated. The shop supervisors must get their organizations back into good working shape just as quickly as possible by being absolutely fair with the men, by insisting upon proper respect and a fair output. The time has gone by when labor can be ruled with an iron hand. Courage, discipline and fair-mindedness are now the qualities which distinguish the successful supervisor.

Report on Standard Locomotives

In the annual report of Director General McAdoo, which was not released in time to incorporate in this issue, an outline is given of the reasons for standardizing locomotives. They sum up as follows:

"First.—To reduce to a minimum the time required to prepare drawings, patterns and dies and thus enable deliveries to begin more quickly than where separate drawings and patterns would have been necessary for each lot of locomotives allocated to a particular road.

"Second.—To insure quantity deliveries. This method of construction has resulted in delivery being made at a quantity rate, which would not have been approached had the locomotives been ordered to individual designs.

"Third.—It has also provided a supply of equipment, the parts of which are largely interchangeable, which is available for use anywhere in event of congestion. This removes the necessity of carrying a large stock of repair parts particular to the locomotive and avoids delay which results when repairs must be ordered from some distant owning road."

It may be safely said that thus far none of these aims has been reached. In the first case, new drawings, patterns and dies had to be made for these standard locomotives and it stands to reason that had the roads which needed locomotives been permitted to order locomotives to existing designs, which was so strongly urged last spring, it would have been unnecessary to prepare these new drawings, patterns and dies and that deliveries could have been made much more quickly and with less labor and expense. In fact, to realize anything on this particular point, which by the way considers only the manufacturers of locomotives, standardization would have to extend over many, many years.

The discussion of the first point covers to some extent the second—to secure quantity deliveries. In commenting on this point the director general says: "During five weeks, beginning July 20, an average of 13 1-5 locomotives per week were turned out at the Dunkirk plant (of the American Locomotive Company) while during five weeks beginning September 14, an average of 19 1-5 locomotives per week were turned out at the same plant." The answer to this is that had the roads been permitted to order locomotives to existing designs, as mentioned above, and had not the builders been required to prepare drawings, patterns, dies, etc., for the new standard designs, the average output during the five weeks beginning July 20 would have been larger than that cited by the director general and the railroads of this country would have received locomotives when they needed them most and not after the war was over.

Under the third point the director general says: "This removes the necessity of carrying a large stock of repair parts particular to the locomotive and avoids delay which results when repair parts must be ordered from some distant owning road." During the latter part of the year when the standard locomotives were being placed in service in large numbers, and at the present time, the reverse of this is true. Every road that handles a standard locomotive must enlarge its stock of repair parts in order properly to handle the standard locomotives. The director general in commenting on this point goes on to say: "The importance of this is forcefully illustrated by an instance where a leased locomotive was held out of service until over \$4,800 rental had accumulated, waiting for a part which would cost not to exceed \$30." This statement, the truth of which is not to be questioned, coming from the source it does, will appear to any practical railroad man as being utterly absurd. Any mechanical department officer that would permit such a thing to happen when he has the shop facilities usually found on a railroad with which to make the missing part costing \$30, should not be permitted to hold a position of authority. At best it must be assumed that this was an extreme and isolated instance.

The thought the director general endeavors to convey by this statement applies more particularly to the standard locomotives at the present time than to leased locomotives, for the reason that the owner of a locomotive must have repair parts that are available for the borrowing road, whereas every user of the standard locomotives must either make the new repair parts or obtain them from the equipment manufacturers. As these locomotives are scattered throughout the country, much labor and expense will be involved to provide these parts properly to take care of the locomotives wherever they may be. This third point can only be realized, as in the case of the first and second, after standardization has been in effect for a large number of years, all of which seems to indicate that the director general in following such a plan was giving far more thought to the establishment of a permanent policy for the future than to the immediate problem of winning the war—the only purpose in establishing government operation.

The entire locomotive standardization program, it would seem, favored far more the builders of locomotive equipment than the railroads that are to use these engines. The advantages to the builders will be short-lived and were obtained, as shown above, at a sacrifice in the year's output, while the disadvantages to the railroads will exist 15 or 20 years, or, for the life of the standard locomotives they operate. If standardization were to continue it would be 10 to 15 years before any beneficial effect could be obtained from the standard locomotives from a maintenance standpoint. Even after the government releases the control of the roads and the railroads have control of the purchases of locomotives, tools, taps, dies, patterns, etc., must be carried in stock to maintain these standard locomotives. On one road in particular a complete set of patterns will have to be made for the standard locomotives assigned to it, as no part of them is common to those of its own locomotives. Grates, pistons, cylinder heads, cylinders and parts, crossheads, driving boxes, shoes and wedges, ashpan casings, crown brasses, engine trucks, tender trucks and trailer truck brasses and boxes will have to be obtained to meet these new designs. In addition, many fittings are entirely different from those that have been used on that road for many years.

In the case of one road to which a number of the standard locomotives were sent, they were found to be inferior to the road's own locomotives of but slightly less tractive power, particularly in the amount of fuel used. This same road has had much trouble with the stoker equipment, which is of a different design from that used on the road's other locomotives. Engine failures have been caused on account of this, which have delayed traffic and necessitated the use of relief locomotives. The engines were held out of service waiting for repair parts with which to repair the stoker. If the road had had the privilege of specifying the equipment desired it would have ordered that with which its other locomotives were equipped and with which its engine crews were familiar and for which it had a stock of repair parts.

On another road several standard locomotives were delivered almost before the road knew it was to receive them. They were delivered under their own steam and one arrived with the grates burned out. As all grates had to be changed, the engines had to be held out of service until the work was done. The rod packing used on these engines was of a different design from any used on that road, although other standard locomotives were equipped with packing that conformed to its standards. As no packing was sent with the engines, delays were caused until the road procured the proper packing for the engines. One of the engines met with an accident and as there were no spare parts and no drawings of the standard locomotive, a draftsman had to go out on the road to the engine and make a sketch of the parts needed for patterns and forgings to make repairs. This required holding the locomotive out of service for some time.

It will be seen, therefore, that locomotive standardization cannot be considered as a war measure, as the advantages sought could not be obtained unless the war lasted many years. It seems to have been more a part of a well defined scheme for complete nationalization of the railroads in this country.

The Railway Crisis

The director general of railroads has just appeared before the Senate Committee on Interstate Commerce to explain the work of the Railroad Administration during the past year, and to tell why he thought it was necessary to extend government control for a period of five years. He has also made public that part of his report to the President covering the activities of the Division of Operation. Under ordinary circumstances we could well afford to congratulate ourselves upon the fact that the railroads of this country made a splendid record during the past year in transporting the increased traffic, made necessary by war conditions, and in helping to win the war. No one wishes to take any credit from Mr. McAdoo or the Railroad Administration, but when the director general deliberately tries to make out a case for the Railroad Administration and show why it should be given a period of five years in which to develop the advantages of unified control under peace conditions, it clearly becomes our duty to disagree with him.

The *Railway Mechanical Engineer* has always been firmly of the opinion that a serious mistake was made when the government took over the actual operation of the railroads. This was unnecessary, as has been clearly shown by the results that have been obtained in Great Britain. That country, on the basis of the experiences in the Franco-Prussian war, made plans for the government control of its railroads during emergency as far back as 1871. When it entered the war in 1914, it took over the control of the roads, but left their operation in the hands of a board of railroad executives. The government simply guaranteed the earnings on the basis of 1913, the pre-war year, and lent all of its authority and power to the railway executives who were placed in charge of the actual operation. As a result, the English railways will probably go down into history as the best managed and operated of any of those of the countries which were engaged in the war.

In this country, a Railroads' War Board had been formed directly after our entry into the war and had given excellent results, considering the fact that it was hampered by the restricting and conflicting regulations of the federal government and 48 states. Two of the factors which were largely responsible for the government taking over control of the railroads were the financial difficulties in which the roads found themselves, because of the rapidly increasing costs and the fact that the Interstate Commerce Commission would not grant an increase in rates, and also because of the serious congestion which was caused, to a very great extent, by the fact that officers in various departments of the government were allowed to issue priority orders without regard to other departments and with no relation to the real order or necessity in which the material was actually required.

The government, by simply taking control and guaranteeing the earnings, and leaving the operation in the hands of the Railroads' War Board, with full responsibility, could undoubtedly have done all that the director general of railroads was able to do and not with the break-down of morale which followed when Mr. McAdoo made such radical changes last winter. One of the greatest shortcomings of the Railroad Administration has been that it has not given the thought which it should to the importance of the human factor in railroad operation. Whether it intended to have it so or not, the impression was widespread that it deliberately in-

tended to discredit the officers. The effect of this upon the morale and discipline throughout the entire organization was disastrous. It is perfectly true that many of the things that were done by the director general, looking toward unification of operation and facilities, were productive of good results. It must be remembered, however, that many of these things had been proposed by the Railroads' War Board but could not be carried out because of laws and regulations under which the railroads were formerly forced to operate.

The labor problem, under private management, was a most serious one. There is no reason, however, why it could not have been solved just as well by railroad executives as by the director general, providing the Interstate Commerce Commission had granted the necessary increase of rates, and this the commission could have been forced to do by the government. One splendid thing has been accomplished by Mr. McAdoo and his Railroad Administration, and that is that so much publicity has been given to the railroad problem, that the public generally is thoroughly awakened to it and is beginning to take the intelligent interest that it should in its final solution. President Wilson frankly stated to Congress that he had no solution for the railroad question, but only a few days later Mr. McAdoo announced that it would be necessary to grant a five-year extension for government control and that if Congress did not take immediate steps in this direction, the roads would be turned back to their owners without any opportunity for remedial legislation. The announcement was also made that the President agreed with him as to this. Just why statements should have been made that it would be necessary to turn the roads back immediately to their owners if the extension was not granted has never been made clear, and there are not a few who suspect that Mr. McAdoo was trying to stampede Congress and the railway executives and force them to the five-year plan.

Fortunately, Congress was not stampeded and the Senate Committee on Interstate Commerce is now engaged in holding a series of hearings during which representatives of all of the important organizations or interests will be heard. Manifestly, it will not be possible to handle the matter to completion during the present session of Congress, which ends next March. The railroad problem, however, is of such tremendous importance to the nation at large that the President will be fully justified in calling a special session of the new Congress to continue the studies and develop the necessary legislation.

Many different plans have been put forward in order to provide the legislation which will be necessary before the roads can safely be returned to their owners. Unless some provision is made to guarantee their financial returns or to insure adequate revenues, it will be disastrous to return the roads to their owners. Moreover, the railroads must be relieved of the conflicting and restrictive regulation of the federal and 48 state commissions; this can possibly best be done by federal incorporation, thus bringing all of the railroads directly under the federal authorities and, at the same time, insuring that careful attention will be given to the issuance of securities which will tend to restore confidence on the part of the security holder and investors. In order to retain those features of unified operation that have given good results during the past year, it will be necessary to repeal the Sherman act, so far as it relates to the railroads. The central regulating authority will have to be more constructive and have a larger responsibility than is now given to the Interstate Commerce Commission. Doubtless, it will be necessary to reorganize and enlarge this commission, and the suggestion has come from other sources that a secretary of transportation be appointed, who will report direct to the President and be a member of his cabinet.

It is noteworthy that the Interstate Commerce Commission has gone strongly on record before the Senate Commit-

tée against government ownership and that it believes that it will be advisable to retain a certain amount of competition between the different roads, in order to develop initiative and give the public the best possible service. One of the most difficult phases of the whole problem is the so-called "weak sisters". These are the weaker and less favorably located roads that cannot exist on rates that would give a good return to the stronger roads. Many suggestions have been made as to combinations which might be formed, and there have been strong advocates of dividing the country into various regions and unifying railroad operation in each region. On the other hand, there has been quite some opposition to this proposal, and the Interstate Commerce Commission in particular suggests that the problem might be solved in a more logical way by arranging for a combination of the weaker roads with adjacent strong roads. Such combinations would, of course, have to be carefully supervised, and it would be specially important not to allow any of the weaker roads to be isolated, so that they would have to stand by themselves.

Hundreds of suggestions are being made as to how Congress should handle the entire problem. It is of great importance that the return of the railroads to their owners should be accomplished with as little disturbance to the public as possible, and that there should be no attempt at experimentation, or in taking radical and unnecessary steps. The railroads of this country pay the best wages and give the best service, at the lowest cost, of any railroads in the world. Common sense would seem to indicate that it will be wise to remove those restrictions that have hampered the continued development of the roads and that, if necessary, the solution of the railroad problem be made in more than one step, if it is not possible clearly to determine the final solution without too much experimentation.

Cost of Locomotive Repairs

While it is extremely difficult with the statistics now at hand to obtain a precise idea of the increase in the cost of locomotive repairs during the past year, sufficient information is obtainable to show that it has increased at a tremendous rate. This is due, of course, very largely to the fact that on account of the war, prices of labor and material have increased greatly. It is also due to the fact that a very strong effort has been made during the past year to keep locomotives in repair and to build up a reserve of power for the winter months to preclude any serious shortage of power such as crippled the roads so badly during the extreme winter last year. The very trying experiences of last winter made it apparent that drastic steps must be taken to prevent its recurrence and when the weather became more favorable in the Spring the Railroad Administration was determined that locomotives should be repaired regardless of cost. The shop hours were increased to 70 hours a week, wages were very materially increased and a basic eight-hour day granted in order to keep the men on locomotive work. Engines were sent to foreign shops that were able to handle repairs in addition to their own; old locomotives that under ordinary conditions would have been scrapped were repaired and every step possible taken to improve the locomotive condition situation.

It has been difficult to get a very comprehensive idea of the increases in the cost of locomotive repairs due to the fact that most of the roads have included in their monthly statements back pay for preceding months. From those roads on which the amount of back pay was deducted from the cost of repairs it has been found that 100 per cent. increase in the cost of locomotive repairs per locomotive mile over pre-war conditions is a very conservative estimate. On one road in particular, the cost of repairs per locomotive mile for June, 1918, was 113 per cent. greater than in June,

1916. In August, 1918, it was 114 per cent. greater and in October, 1918, 91 per cent. greater than the corresponding months in 1916. For the first ten months of 1918 the costs were 76 per cent. greater than for the same period in 1916. This, however, does not show the real situation, as none of the back pay for the first part of the year was included in the comparison. On another road a fair estimate for the first six months of 1918 was 100 per cent. greater than for the same six months in 1916. The locomotives being now in such good condition, as reflected by the reports from Washington, which are published elsewhere in this issue, and the extreme demand for power removed, it is to be anticipated that the cost of locomotive repairs for the coming year should be less.

NEW BOOKS

Proceedings of the American Railway Master Mechanics' Association. Edited by V. R. Hawthorne, secretary. 528 pages, 33 plates, 6 in. by 9 in., bound in cloth. Published by the association, 746 Transportation building, Chicago. Price \$5.

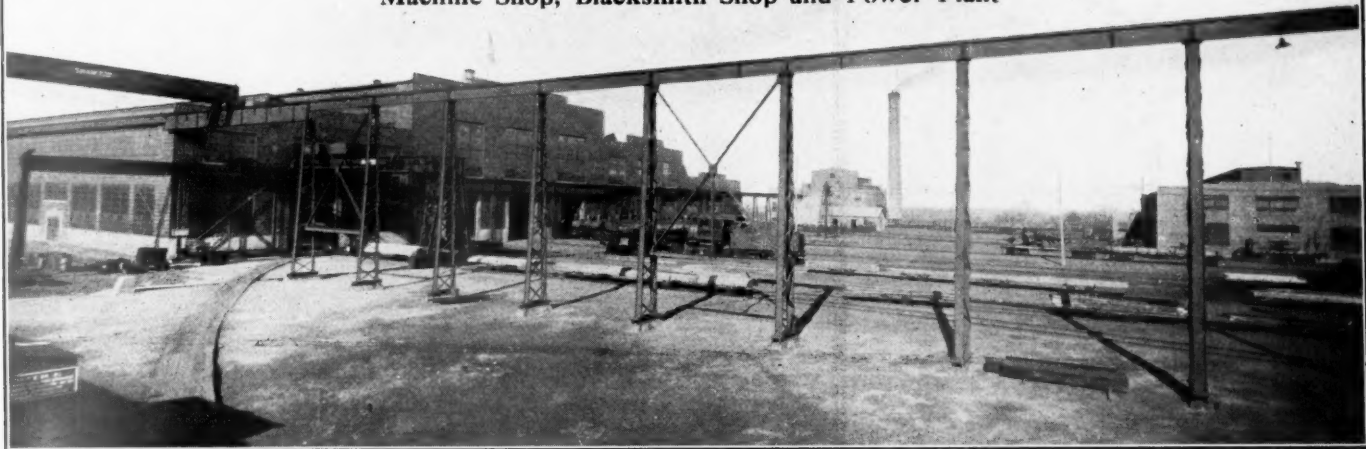
The fiftieth volume of the Master Mechanics' Association Proceedings, which has just been issued, covers the activities of the organization during the years 1917 and 1918. A large part of the book is devoted to an account of the convention of 1918, which includes several valuable committee reports. The report on the shop manufacture and repair of semi-elliptical springs covers the subject very thoroughly. The report on the design and maintenance of locomotive boilers is devoted principally to a discussion of the field for autogenous welding in boiler work. The committee on fuel economy and smoke prevention outlined briefly the problem of fuel economy on railroads and made specific recommendations concerning the methods of handling storage coal. The committee on train resistance and tonnage rating submitted data secured from train resistance tests and engine tests. Several important changes were made in the specifications, standards and recommended practices of the association. The development of feedwater heaters is covered very thoroughly in an individual paper by J. Snowden Bell.

Proceedings of the International Railway General Foremen's Association.—Compiled and published by William Hall, secretary of the association. 63 pages, 6 in. by 8¾ in., illustrated, bound in leather.

Although the International Railway General Foremen's Association did not hold a convention during 1918, it has in an endeavor to carry on its work of improving mechanical department conditions published the papers prepared by its members which would have been presented had a convention been held. The association is to be congratulated on thus attempting to keep alive its good work and its various members will undoubtedly appreciate the time and effort taken by the committee members in preparing papers for their benefit. The proceedings contain an address by President North, superintendent of shops of the Illinois Central at Chicago, by Robert Quayle, general superintendent motive power and machinery of the Chicago & North Western and by Dr. Frank Crane and in addition the annual report of the secretary-treasurer. The following subjects were discussed by various members of the association: What effect has the war had upon your shop methods and what changes for the better are the result thereof?—The mileage of a locomotive; its relation to the cost of shop and running repairs; who should determine when to shop an engine and who should furnish the work report?—Economical and necessary electrical equipment for railroad shops and roundhouses—Is the flat rate of pay for various classes of labor a success? Should the minimum rate accepted by various organizations be the maximum rate allowed by employers?—How best can greater output by unit of labor be obtained—and, How can uniform classification of repairs to locomotives be brought about?

WEST BURLINGTON SHOPS OF THE C. B. & Q.

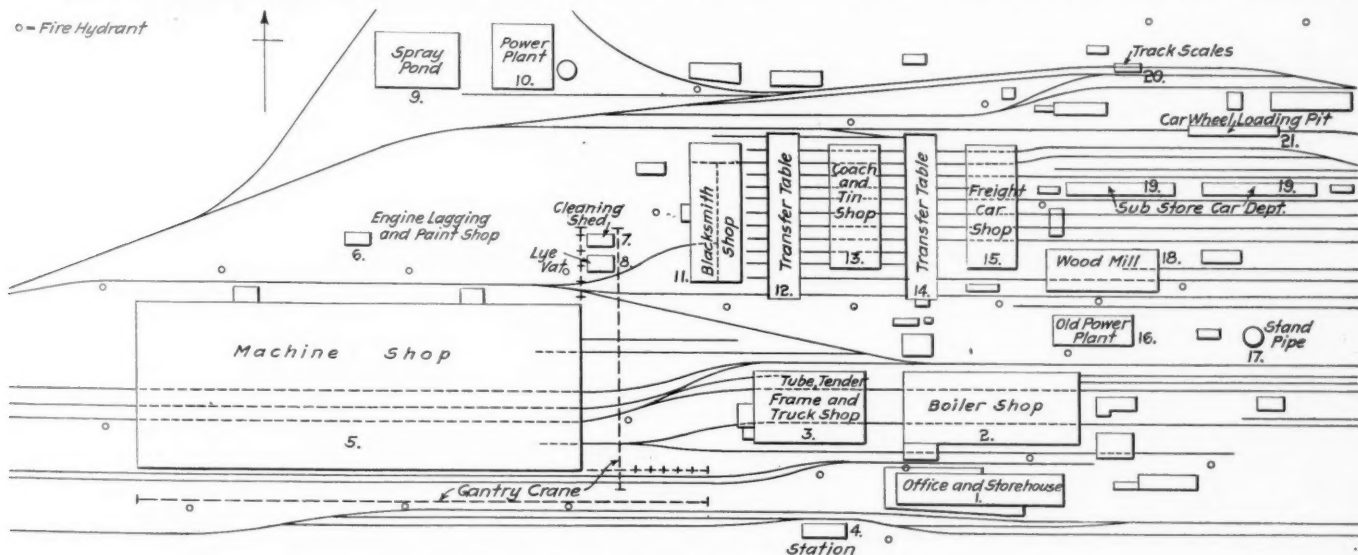
Equipment and Operation of New Erecting and Machine Shop, Blacksmith Shop and Power Plant



IN 1917, the Chicago, Burlington & Quincy made extensive additions to its shops at West Burlington, Iowa. These included a new power plant, a blacksmith shop, and a combined machine and erecting shop which surpasses in size any similar structures that have yet been built. The expansion of the facilities at this point was made necessary by the increase in the amount of motive power in the district which the shop served and the crowding of neighboring shops. West Burlington is on the main line between Chicago and Omaha, and points farther West. The other principal shops on this line are at Aurora, Ill., 173 miles east of West Burlington and at Havelock, Neb., 336 miles to the West. Burlington, Iowa, four miles east of West Burlington is an

important division point on the main line between Chicago and Omaha and is the center of a net work of feeders running throughout western Illinois, Iowa and Missouri. The shops are therefore centrally located with respect to a large amount of motive power.

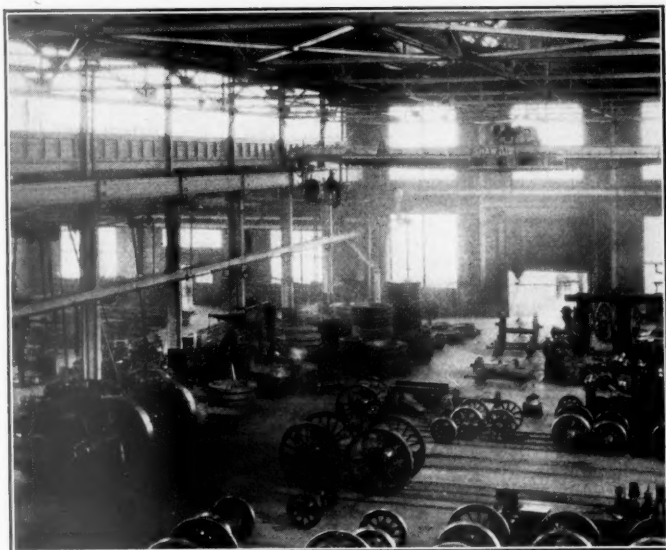
The problem involved in enlarging the shop was one often met with, namely, to utilize existing facilities to the best advantage in connection with a large extension. The shops as they stood prior to 1917 were built in 1882. At this time a tract of land comprising 640 acres was purchased and the West Burlington shops were erected, much of the equipment being moved out from Burlington. The plant as built at that time comprised seven principal buildings; a storehouse



Plan of Tracks and Buildings, West Burlington Shops

List of Buildings

	Material	Size	Year built		Material	Size	Year built
1 Office and storehouse	Brick	55 ft. 8 in. by 301 ft. 6 in.	1882	11 Blacksmith shop	Steel and brick	90 ft. by 250 ft.	1916
2 Boiler shop	Brick	125 ft. 1 in. by 315 ft. 8 in.	1882	12 Transfer table	Stone	58 ft. by 300 ft.	1882
3 Tube, tender frame and truck shop	Brick	125 ft. 1 in. by 200 ft.	1882	13 Coach and tin shop	Brick	90 ft. by 222 ft.	1882
4 Station	Wood	20 ft. by 50 ft.		14 Transfer table	Stone	58 ft. by 300 ft.	1882
5 Machine shop	Steel and brick	310 ft. by 792 ft.	1916	15 Freight car shop	Brick	90 ft. by 22 ft.	1882
6 Eng. lagging and paint shop	Stucco	18 ft. by 52 ft.	1917	16 Old power plant	Brick	140 ft. 8 in. by 52 ft. 10 in.	1882
7 Cleaning shed	Stucco	18 ft. by 52 ft.	1917	17 Stand pipe	Steel	28 ft. diam. 60 ft. height	1909
8 Lye vat	Concrete	28 ft. by 28 ft.	1916	18 Wood mill	Brick	75 ft. by 200 ft.	1882
9 Spray pond	Concrete	100 ft. by 150 ft.	1916	19 Sub. store car dept.	Wood	11 ft. by 175 ft.	1900
10 Power plant	Steel and brick	106 ft. 8 in. by 118 ft.	1916	20 Track scales	Wood	8 ft. by 50 ft.	
				21 Car wheel loading pit	Concrete	22 ft. 6 in. by 110 ft. 1 in.	



Wheel Department in the Heavy Machine Bay

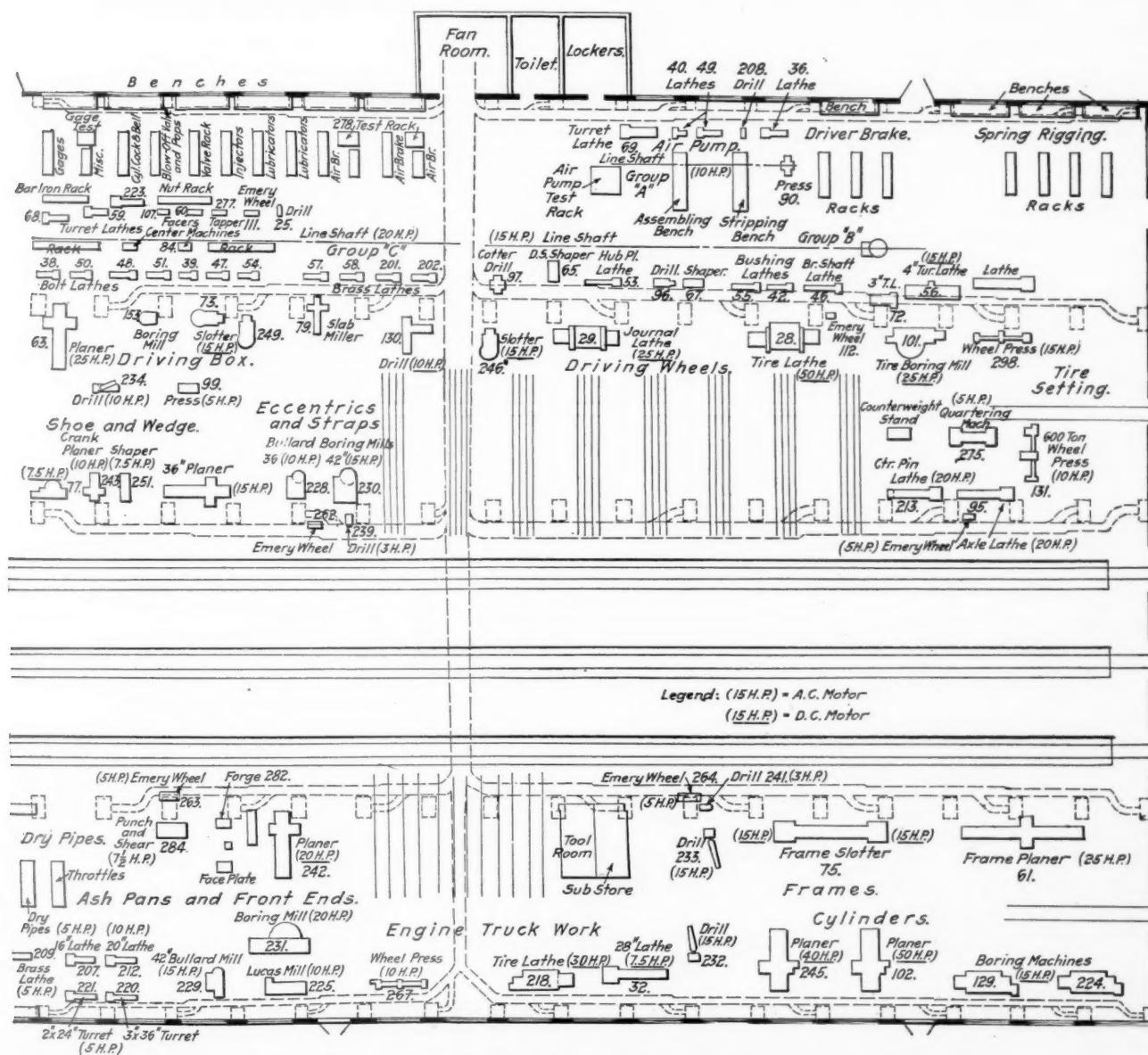
ference with the car department to any appreciable extent, so it was decided to place the new shops west of the existing

plant. A study of the requirements showed that but one department could be housed in the old shop buildings. It was therefore decided to build a combined erecting and machine shop, a blacksmith shop and power plant in the locations shown on the map below. The new erecting shop has a capacity of approximately 30 large or 45 small locomotives, including two or three being stripped and three or four being wheeled and finished.

STRUCTURAL DETAILS OF BUILDINGS.

The buildings in the new plant were erected by Westinghouse, Church, Kerr & Company, New York. The machine and erecting shop is a steel frame building 792 ft. long and 310 ft. wide. The total floor area is 5.65 acres. The entire floor space is made of concrete. The foundation is of concrete and the walls are concrete and glazed hollow tile. The roof is made up of three-inch Douglas fir planks, supported on fir purlins and covered with tar and gravel. The building is divided longitudinally into four bays, one for the erecting shop, two for heavy machines and one for light machines.

The erecting shop occupies a bay 100 ft. wide and three pits, spaced 30 ft. apart, run longitudinally through its entire length. There are four cranes spanning the bay, two of 125 tons' capacity with 15-ton auxiliary hoists on the



Floor Plan of East End of Erecting and Machine Shop, Showing Arrangement of Machine Tools.

upper runway and two of 15 tons' capacity on the lower runway.

On the south side of the erecting shop there is a bay 70 ft. wide served by one 15-ton crane. This part of the building contains some of the heavy machine tools, but the greater part of the space is used for overhauling engines, trucks, ash pans, steam pipes, superheaters, stokers and



Half-Gantry Cranes Along Side and End of Shop

stoker engines and cabs. A standard gage track leads into the east end of this bay.

A heavy machine bay is placed on the north side of the

shop is the light machine bay, 70 ft. wide. This section has no traveling crane but numerous jib cranes are provided for the heavier work. The tool room is located midway along



The Rod Department

this bay. In one corner there is a room for the storage of hand tools and blue prints, and directly above this is the foreman's office.

The walls of the shop have a large area of windows which are set in steel sash having sections pivoted horizontally to provide for ventilation. The natural light is increased by a double pitch skylight in the erecting bay and sawtooth skylights running almost the full length of the three remaining



Interior of Erecting Shop

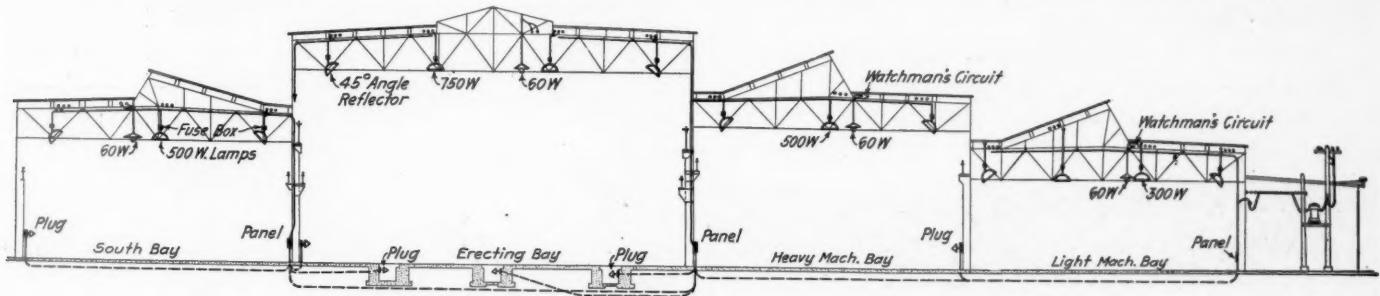
erecting bay. It is 70 ft. wide and has two 15-ton electric traveling cranes covering the entire area and has a stub track leading into it from the east. Along the north side of the

bays. A good idea of the uniform lighting across the shop can be gained by referring to the cross section of the building.

The shops are lighted at night by nitrogen filled lamps in

enameled steel reflectors. The general illumination is ample for working on machine tools or around locomotives. Plug receptacles are provided, however, spaced 20 ft. apart in the erecting pits and 40 ft. apart on the walls and col-

this system can be used for forcing air through the shop to create an artificial circulation. The water supply for fire protection is taken from two reservoirs about half a mile from the shop. The pumps discharge into a stand pipe 28



Cross Section of Shops, Showing Arrangement of Lighting Fixtures

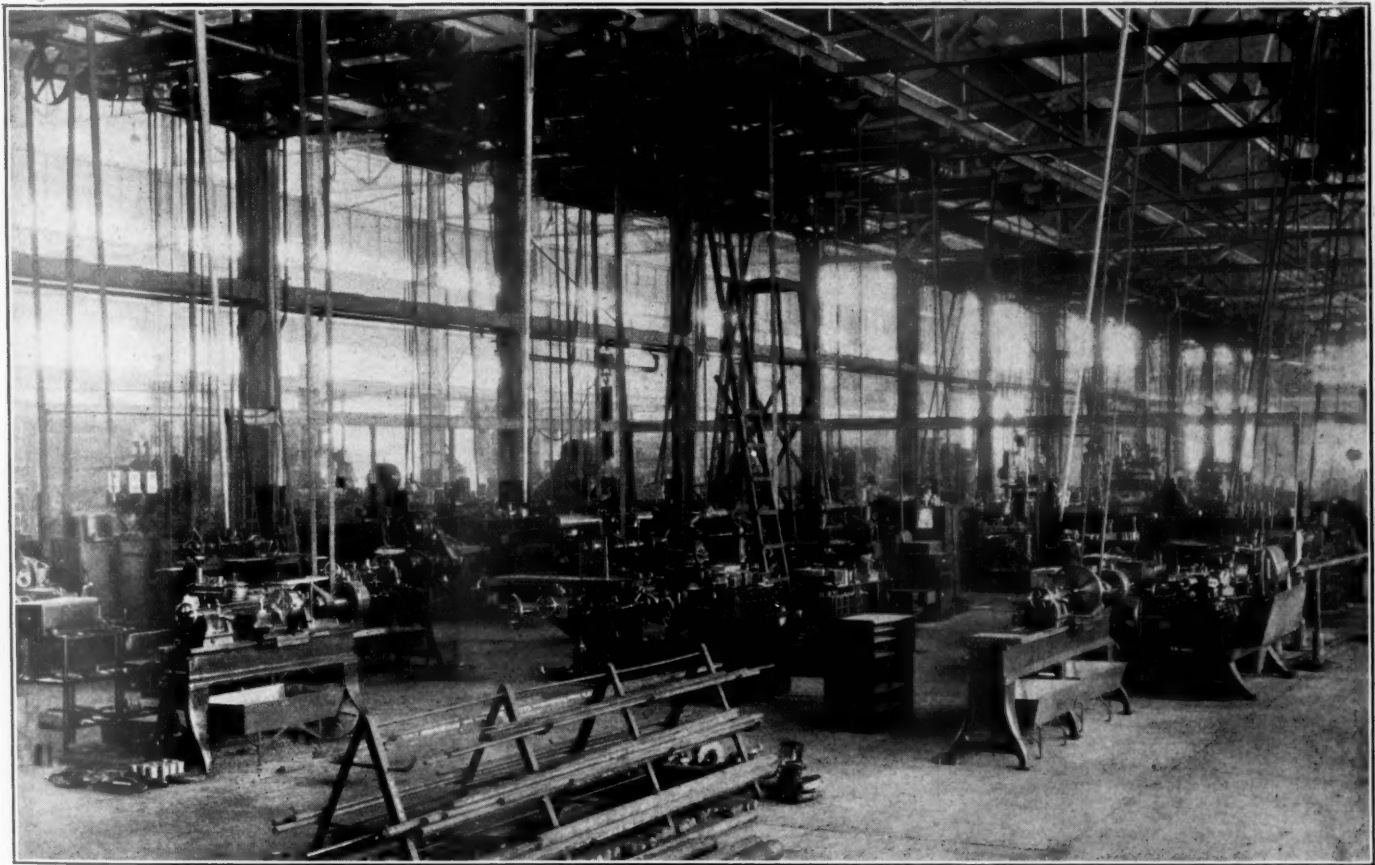
umns. Data concerning the lighting installation is given in the following table:

	Approximate height	Number of lamps	Size of lamps	Watts per sq. ft.	Approx. ft. candle intensity
Light machine bay.....	23 ft.	144	300	.78	5.5
Heavy machine bay.....	33 ft.	87	500	.78	5.0
Erecting shop.....	50 ft.	72	750	.68	4.5
South bay.....	33 ft.	87	500	.78	5.0

An indirect fan system of heating is used. The air is drawn in at two fan rooms which extend out from the north

ft. in diameter and 60 ft. high, having a capacity of 275,000 gal. Hydrants are spaced from 200 to 400 ft. apart around the shop. A separate pipe line is provided for drinking water. The main toilet rooms are located in the additions, which house the ventilating fans, several auxiliary toilets being provided at convenient points in the shop. The wash rooms and locker rooms are on the second floor of the two additions.

The blacksmith shop is a brick building with a steel frame and concrete foundation 250 ft. long and 90 ft. wide. A



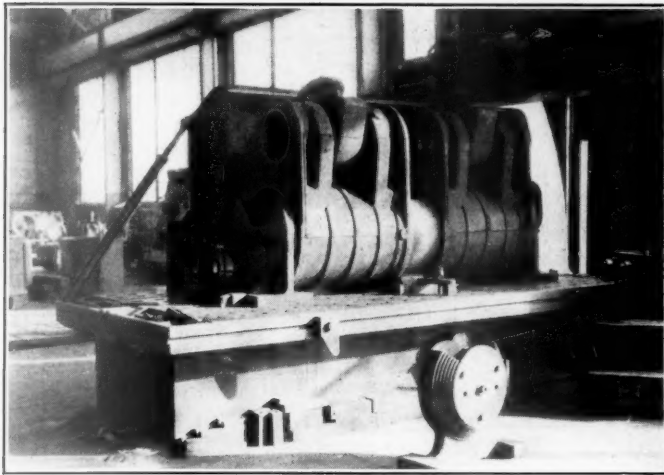
Interior of the Tool Room

wall. The fan forces the air through the heating coils, which are supplied with exhaust steam from turbines, and one air compressor in the power plant and thence into concrete ducts under the floor. These ducts branch into smaller tile ducts which are carried up to sheet metal cowls with outlets about three feet above the floor. During extremely warm weather

louver with pivoted steel sash windows in each side extends along the center to provide an outlet for smoke and gases. The roof is of the same type used on the erecting and machine shop.

The power house is a steel frame brick building 118 ft. by 107 ft. with a basement under both the boiler and the

machines for the stock of parts undergoing repair, and second, to permit of arranging the machines in the order that would eliminate backward movements as far as possible. It



Cylinder Set Up on Jigs for Planing

should be noted that the machine shop area includes also the sub-department in which the ash pans, front ends and super-

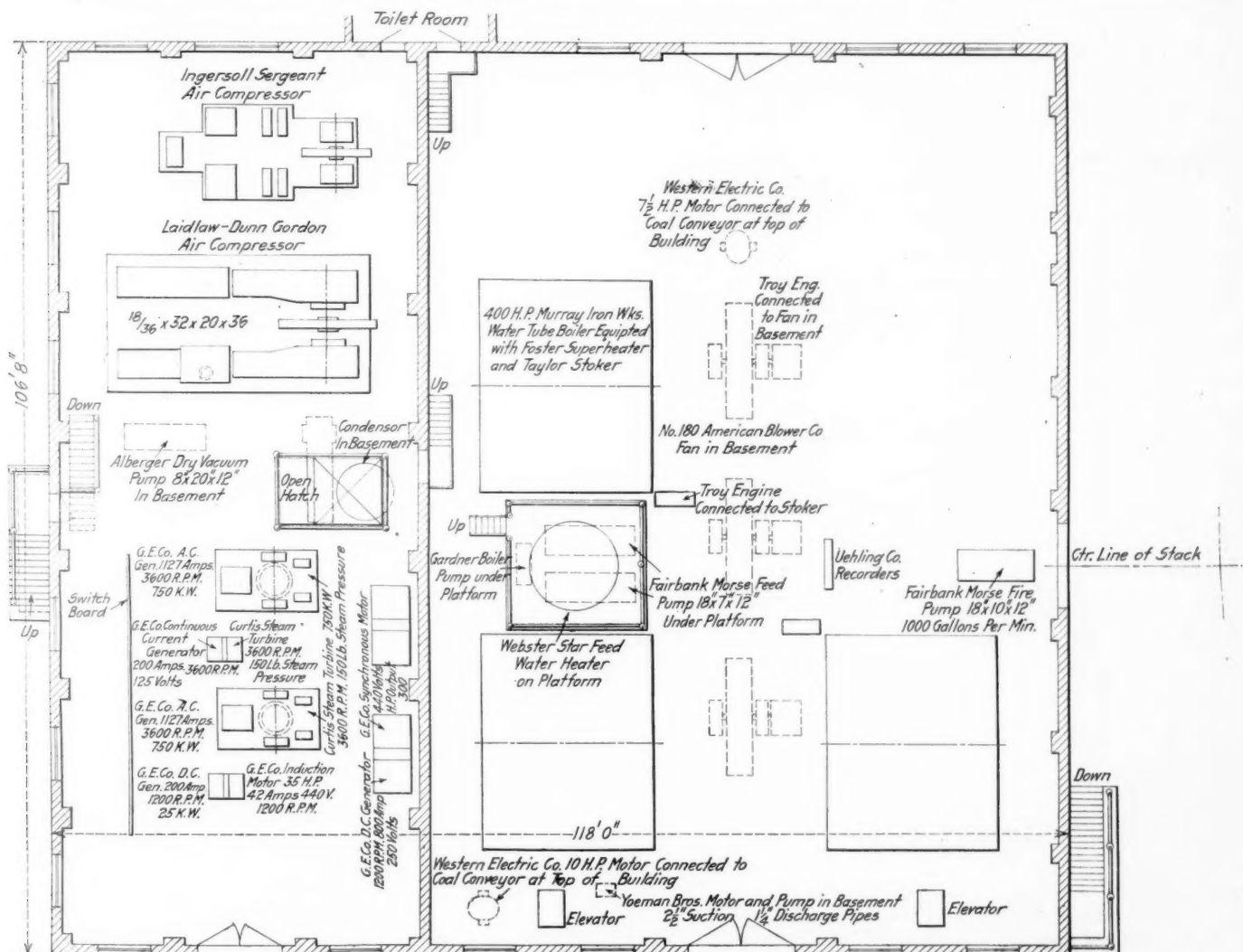
repair points on the system. The space devoted to blacksmith work is relatively small by comparison with the average for older shops, although work for both locomotives and cars is handled here. This is undoubtedly to be explained by the increase in the parts for which steel castings are used, with a consequent reduction in the number of forgings that has occurred in recent years.

ORGANIZATION.

The organization of the supervising force in the locomotive department is shown in the diagram. This is closely in accord with general practice and little comment is necessary. It should be noted that piece work is in effect in practically all departments, which accounts for the small number of foremen in the main sections.

ROUTING OF PARTS BEING REPAIRED.

In locating the sub-departments a special effort has been made to group them in a logical order so that related parts are kept together, so that the distance material must be hauled will be reduced to the minimum and so that the parts will all be moving in the same general direction. The location of the machine tools in each sub-department has been studied and they have been arranged to permit material undergoing repairs to pass from one to another in regular order without any back movement. Thus the normal routing



Arrangement of Equipment in Power Plant

heater units are repaired, although this amounts to less than 10 per cent of the total floor space. Furthermore the shop finishes cylinders and other parts for some of the smaller

tor the parts is from the erecting shop to the end of the sub-department nearest the stripping pit, and thence through the machines in rotation, coming out completed at the end of

the department nearest the finishing pits. This arrangement is treated in detail in the description of the sub-departments later in this article.

Ample facilities have been provided for transporting the work in the shops and from one building to another. The erecting shop, as already noted, is served by two 125-ton cranes with auxiliary hooks for lifting 15 tons, and two cranes of 15 tons' capacity running on the lower track. The bay in which the heavy machines are located has two 15-ton cranes and the south bay has one of the same capacity. Along the south wall of the shop there is a track for a 10-ton half-gantry crane, extending nearly to the storehouse. Under this crane most of the heavy material such as cylinders, tires, etc., is stored. The east side of the machine and erecting shop is served by a 50-ton half-gantry crane which reaches the ends of the tracks into the shop and runs beyond the north boundary of the shop to the lye vats. As the runway for this crane extends a short distance under the runway of the 10-ton gantry it is easy to transfer the material by means of these two cranes from the material platform to cars or trucks that can be run into the shop. The flue shop and erecting shop are connected by two direct tracks and two

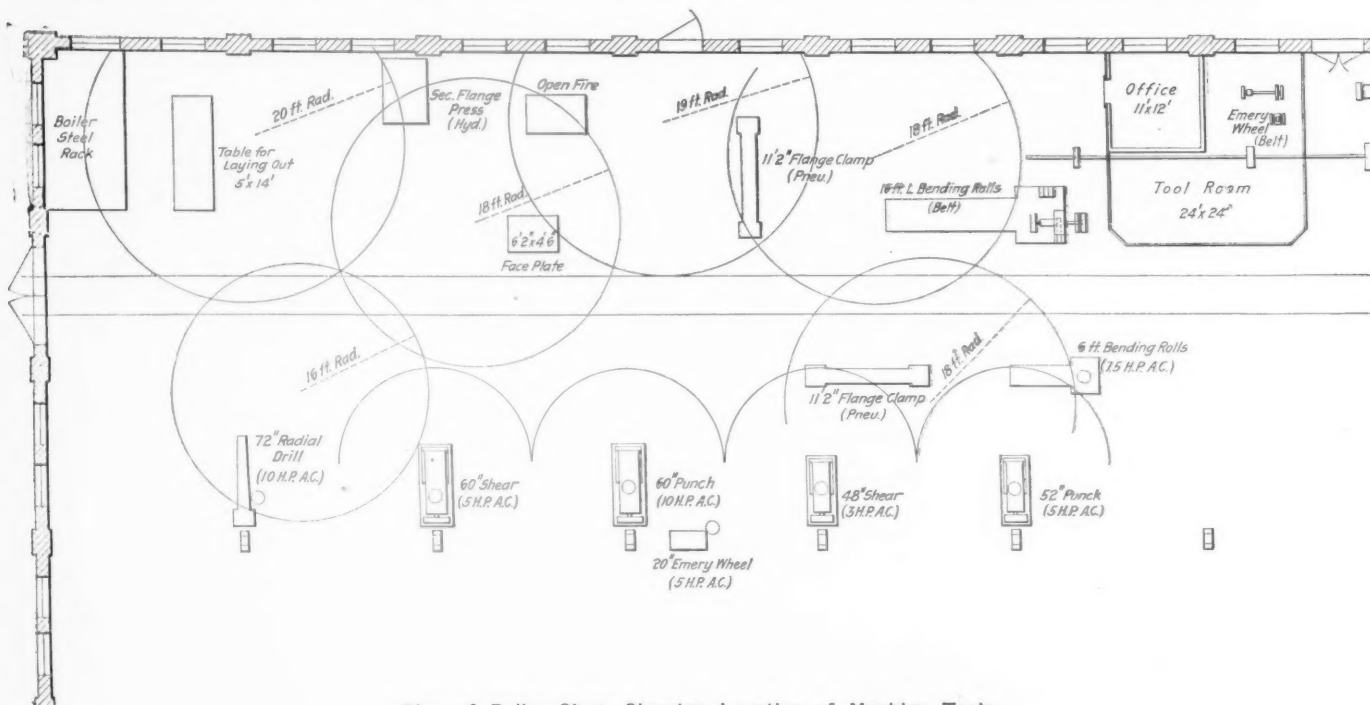
motives. While no enlargement to the shop is planned further extensions toward the west or toward the north are quite feasible.

Ease of observation, important as an aid to supervision, has been given due consideration. The longitudinal arrangement of the pits in the erecting shop enables the foreman to see work being done on several engines from any point. By grouping the tools in the machine shop in single rows with a passageway between, the same object has been accomplished.

SHOP OPERATION.

ERECTING SHOP.

Locomotives awaiting repairs are stored on dead tracks in the yard east of the shops. They enter the erecting shop at the east end where the stripping is carried on. When the stripping is finished the locomotive is set on blocks in the center portion of the shop. If it is necessary to remove the boiler, this is placed on a car and taken to the boiler shop. Flues are cut out, placed on push cars and run to the flue shop. The wheels and driving boxes are rolled out under the 50-ton gantry crane, which takes them to the lye vat. The



Plan of Boiler Shop, Showing Location of Machine Tools.

others lead into the tender truck repair shop. A separate track goes to the boiler and tank shop, which can also be entered by two tracks at the east end. The blacksmith shop and erecting shop are joined by a board path over which electric storage battery trucks are operated and there is also a standard gage track extending from under the 50-ton gantry crane runway to the track through the center of the shop.

One of the things that frequently causes trouble in railroad shops is local congestion due to the inability to predetermine accurately how much room will be required by each department. In this instance, space has been left between most of the departments. This gives extra floor area for the material and provides leeway for future growth. The extra space has been apportioned with considerable judgment, for instance, it seems likely that the number of stoker fired engines will increase and therefore the stoker department has been allowed room to grow. On the other hand, the work on eccentrics and straps is handled in the smallest possible area because these parts are not found on modern loco-

pedestal binders crossheads, links, hangers and similar parts are placed in containers to facilitate the cleaning. The front ends are stored in a rack adjoining the finishing pits.

HEAVY MACHINE BAY.

Driving Wheels, Axles and Crank Pins.—The driving wheel department is at the extreme eastern end of the machine shop. From the lye vat the wheels are rolled in on a stub track and inspected. If the wheel centers need to be pressed off or crank pins pressed out, they go to a 600-ton wheel press on the left hand side. Beyond the press are located the axle lathe, crank pin lathe, and quartering machine. On the right hand side of the track are the stands for holding wheels while the tires are removed or set. The tires on truck wheels are removed and applied in this department, as there is not enough of such work to justify the duplication of the facilities. Beyond the mounting stands are located the boring mill for wheel centers and tires, a driving wheel lathe and a journal turning lathe. Next in order come the tracks adjoining the fitting bench where hub plates are applied and

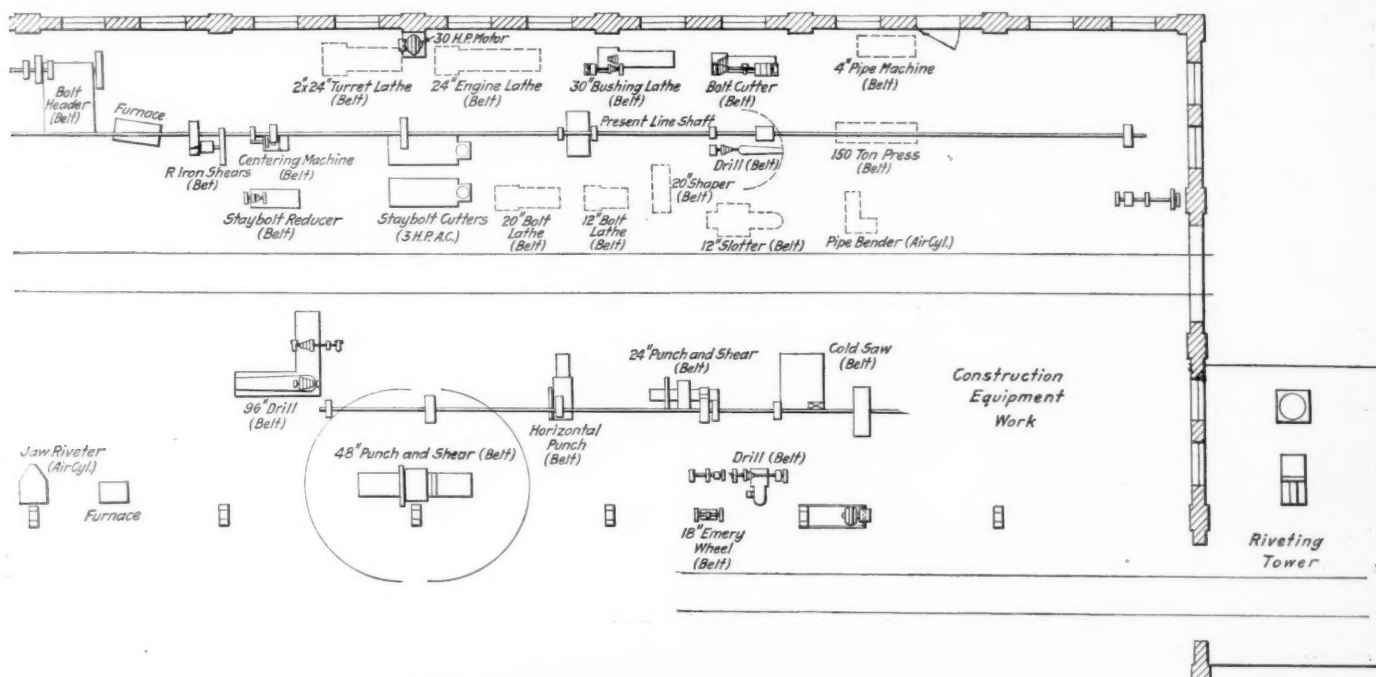
crank pins trued up. The eccentric cranks and eccentrics are fitted on a track next to the eccentric bench, and also adjacent to the driving box department. Wheels are fitted with driving boxes and cellars before they go to the erecting shop. There are 16 tracks for storing wheels, each 35 ft. long, and extending out into the erecting bay to facilitate handling.

Eccentric Department.—The eccentrics and straps are brought from the lye vat to the eccentric department which has a 36-in. Bullard vertical turret lathe, used mostly for turning up brass liners, and a Gisholt 42-in. boring mill used for eccentrics and straps.

Driving Boxes.—The boxes from the lye vat are placed on a platform south of the passage through the machine shop, where they are inspected. Those requiring new crown brasses go to the press, while others are taken to the planer. The crown brasses are shaped on the slotter and then pressed in. The box then follows the same course as those not requiring brasses, going to the planer to be faced on the shoe and wedge fit, and on the hub if necessary, and then to the boring mill. After being bored a clearance for the grease is cut on the back side of the box only on the slotter. The

removed. The rods are next examined for cracks. If they need re boring they are sent to the horizontal boring mill. Next they go to the radial drill to have the taper knuckle joint pin fit reamed out, then the pins are fitted. After this operation the rods are set on a rack at the west end of the rod department and the bushings are fitted on a small boring mill. After the bushings are bored and pressed in, the rods are fitted together and trammed for length, being changed by the blacksmith if necessary. Knuckle joint pins and bushings and crosshead pins are turned up rough on a 7½-in. Libby high duty turret lathe. The sides of main rod straps are trued up on the surface grinder and main rod brasses are shaped to size on two 28-in. shapers with special attachments and bored out on a 36-in. Bullard vertical turret lathe. Side rod bushings are pressed in by a 100-ton hydraulic press.

Valve Motion.—The diversity of work involved in the repairing of valve motion makes it difficult to establish a routing for the parts, except in a general way. However, the majority of parts can be finished on one or two machines and as they are relatively light the handling presents no special difficulty. The rocker arms, lift shafts, bushings, valve



Plan of Boiler Shop, Showing Location of Machine Tools.

lateral play of the driving boxes is governed by the thickness of the hub liner on the wheel center. The flanges on each pair of driving boxes are made the same thickness. The man applying the hub plates takes this dimension off the box with the thickness of the shoe and wedge flanges and the distance over the frames and has the brass hub liners turned to the proper thickness to give ⅛ in. lateral clearance. Each half of the hub plate is put on with four wrought iron pins having a straight fit in the wheel center and a counter-sunk head. When the driving boxes are worn down ⅜ in. the face is counter-bored and a ½-in. sheet steel liner is put on with countersunk head bolts.

Shoes and Wedges.—All new shoes and wedges are finished on a planer near the driving box department. When these parts come from the engine after being laid off, they are faced on a planer in the light machine bay near the west end of the shop shown on the layout as No. 70.

Main and Side Rods.—The rods as they come from the locomotive are placed on rails resting on trestles, the main rods on one side and the side rods on another. They are then cleaned with waste, and grease cups and bushings are

bodies, rings, etc., are handled on two lathes. Pins are roughed out on Jones and Lamson and Pratt and Whitney turret lathes. Pins are fitted on three lathes, one of 16-in. swing and two with a swing of 18 in. The drilling of heavy parts is done on a Baker high duty drill, while lighter work is handled on drill presses in the light machine bay. A planer in the light machine bay handles surfacing operations on links and similar parts.

Pistons and Rods, Crossheads and Guides.—The piston guide, and crosshead work is done at the extreme west end of the heavy machine bay. The machine tools include a 42-in. Bullard vertical turret lathe for turning piston packing, a 36-in. vertical turret lathe for turning valve chamber heads, packing, etc., a Baker high duty drill for miscellaneous drilling and reaming, two piston lathes and an Acme turret lathe. As the pistons come from the locomotive they are set on the floor and examined. The nuts are turned off in a lathe and the pistons are sent to the 250-ton press and the heads are taken off. The rods then go to one of the two lathes and are trued up or if necessary are replaced with new rods. The piston heads are turned up on a boring

mill and come to this department finished except for the cylinder fit. The pistons are put on the rod and the outside is turned and grooved for the packing rings.

Crossheads are set alongside the pistons and rods. The shoes are taken off, and if necessary, the crosshead pin fit and the piston rod fit are reamed. The crosshead shoes go to the babbit furnace to be relined and when they are returned are applied to the crosshead and the bolts are fitted. Then the complete crosshead goes to the planer where the shoes are planed to fit the guides; after which the crosshead pin is fitted. Then the piston rod is inserted and the key shaped to fit. As the final operation, the gland is fitted on and the packing is bored to size.

Crosshead guides coming from the locomotive are placed on a rack from which they are handled by a jib crane onto the surface grinder. After being ground on the face and the sides, they are put back in another portion of the rack, until they are ready to be applied to the engine.

LIGHT MACHINE BAY.

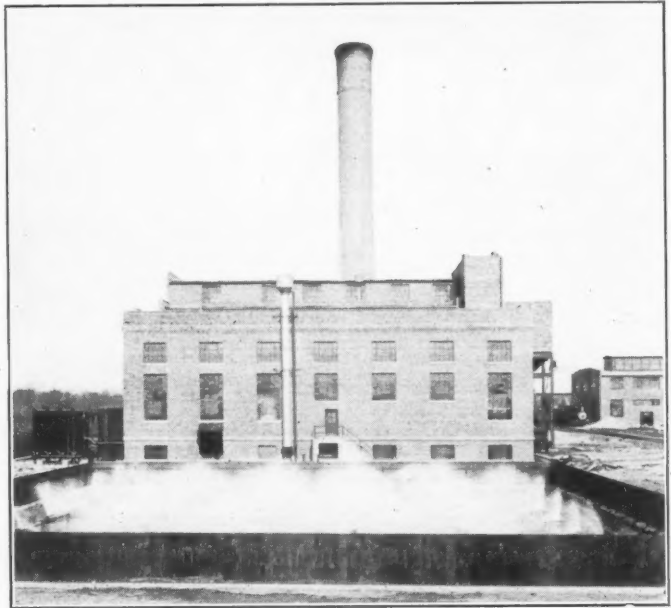
At the extreme east end of the light machine bay the driver brake rigging and spring rigging is repaired. This is largely bench work with the exception of pins and bushings, which are handled on a Warner & Swasey hollow hexagon turret lathe and a Jones & Lamson flat turret lathe. Two engine lathes are used for turning up trunnions, etc., and there are also provided in this department a drill press and a hydraulic bushing press.

Next to the spring rigging department is the air brake department. At the east end air pumps are repaired. Three small engine lathes, a shaper and a drill press are conveniently located to do the work that must be handled on these machines. The lighter air brake parts as well as injectors, lubricators, pops, bell ringers, valves and gages are repaired at benches about half way down the shop. There are three brass lathes and one engine lathe serving this department. Just beyond the brass lathes is the bolt department. In this department there are five turret lathes, seven small engine lathes for fitting belts, a centering machine, a drill press, a nut facer, a 4-in. single spindle tapping machine and a three-spindle bolt cutter.

Tool Room.—The tool room is very completely equipped for light or heavy work. The smaller machines are belt driven from line shafting but the larger lathes have indi-

vidual motor drive. In the northwest corner of the tool room is located a light Beaudry hammer and an oil furnace where chisels and other tools are made and put in shape. The main stock room for blue prints and hand tools is in the corner of the tool room. Above this is the foreman's office which gives a view of the entire north side of the shops. The walls are of glass to give a wide field of vision.

The west end of the light machine bay is occupied by the electrical department. Here repairs to headlight equipment,



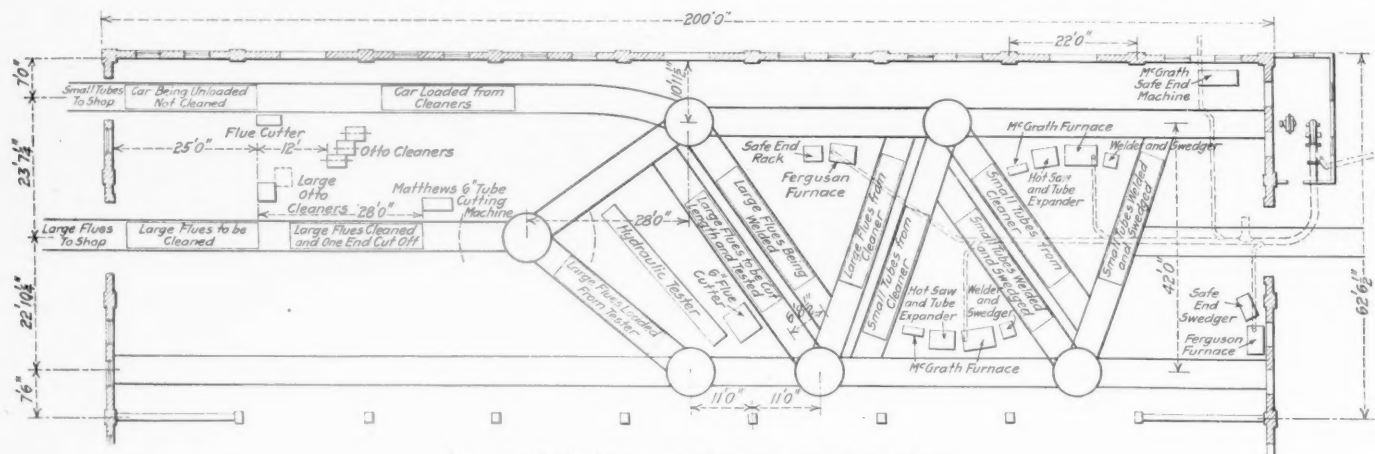
Power Plant and Spray Cooling Pond

motors, gasoline engines and section cars are carried on. A part of the space at this end of the shop is devoted to storage at the present time.

SOUTH BAY.

The large bay south of the erecting shop is equipped to handle the work on frames and cylinders, engine trucks and most of the auxiliary parts of the boiler and the machinery. All the tools in this section have individual motor drive.

Frames and Cylinders.—At the east end of the south bay,



Layout of Machines and Tracks in the Flue Shop

dividual motor drive. There are two cylindrical grinders and one universal grinder. For repetition work such as pins, sleeves, sockets, flue rollers, etc., a Warner & Swasey hollow hexagon turret lathe is used. The repairs to speed recorders are handled at a bench with special fixtures in the tool room. Just beyond the tool room are several benches where machine tools, hoists, and similar machinery, are over-

alongside the erecting shop, is located equipment for planing and slotting frames, consisting of a 60-in. planer, a double head frame slotter and a 96-in. radial drill. These machines are not kept busy on frame work, so they also handle other heavy parts of a miscellaneous character. The cylinder work is done on a group of machines located along the east end of the south wall in the south bay. This consists of a

three-spindle cylinder and valve boring machine, an 84-in. planer with reversing motor drive and a 96-in. radial drill. A notable feature of the work in this department is the extent to which jigs, fixtures and templets are used. Cylinders are finished in considerable numbers and a great deal of time is saved by the device used for lining up the cylinders for planing, which is shown in the illustration, and by the jigs for locating bolt holes not only around the cylinder bore, but also in the frame and saddle fits.

Engine Trucks.—The engine truck department has a



Exterior of the Blacksmith Shop

16-in. engine lathe for bolt work, a 42-in. lathe for truing journals, a Sellers 48-in. car wheel lathe driven by a 50-h. p. direct current motor, and a 400-ton wheel press.

Ashpans.—The ashpan department is equipped with a punch and shear besides numerous pneumatic tools. Adjacent to this department there is a sub-store for bolts, nuts, washers, rivets, etc.

Steam Pipes.—As the repairs of steam pipes, dry pipes

handled in other departments. The stoker engines are overhauled here and are tested before being installed on the locomotive.

Piping and Superheater Units.—The steam and air brake piping and superheater units are handled in the same department. The piping as it comes from the locomotives is thoroughly cleaned in the lye vats and is then placed on racks.

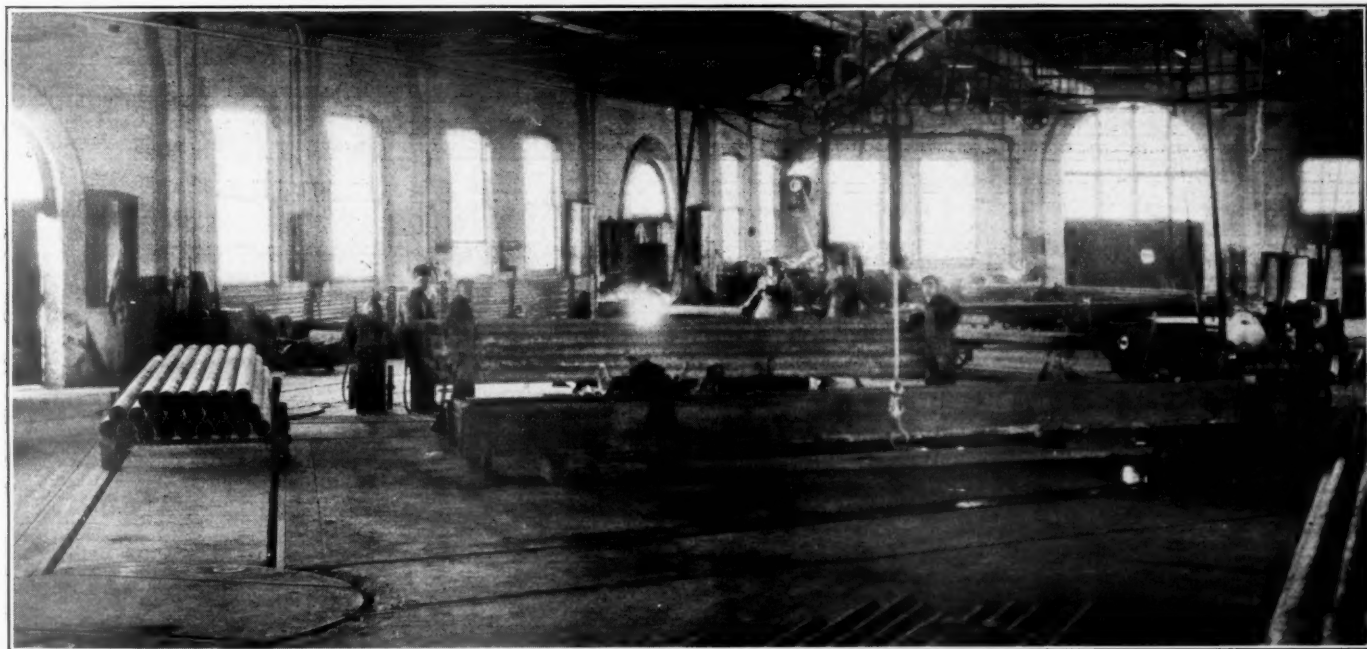
Cab and Upholstery Work.—The cabs used by the C. B. & Q. are mostly of wood with a steel front. To take care of the repairing a small wood working department has been installed at the west end of the shop. Here the cabs and seat boxes are overhauled.

Paint Shop.—A small stucco building north of the erecting and machine shop is used for the storage of paint and also for reworking boiler lagging. Another similar structure near the lye vat is used for reclaiming journal box packing and driving box grease.

BLACKSMITH SHOP.

The blacksmith shop is well equipped to handle heavy or light hammer work, general blacksmithing and bolt making. The heaviest steam hammer is one of 5,000-lb. capacity, with a double frame, which is used principally for making billets from scrap iron. Short pieces of bolts and flat bars are piled on boards and brought to a welding heat in the scrap furnaces and are then shaped into slabs under the steam hammer. These slabs are again piled together and made into billets. Iron of excellent quality is secured in this way. In addition to the 5,000-lb. hammer there is one of 3,000-lb., one of 1,600-lb., five of 1,500-lb., and two of 650-lb.

For making parts in considerable quantity there is a battery of Bradley hammers, including three 500-lb. and one 60-lb. size, a large bulldozer and one 3-in. and two 1½-in.



Interior of the Flue Shop

and throttle valves and superheater headers is largely bench work, this department has but one machine tool, an Acme turret lathe, used for finishing dry pipe rings and similar work. There are a large number of ingenious fixtures used in grinding joints with air motors.

Stokers.—A considerable amount of space is devoted to stoker work, but as the majority of these parts are maintained to standard sizes, the machine work required is

forging machines. The Bradley hammers and forging machines are belt driven from a line shaft, while the bulldozer, punches and shears are direct connected. At the south end of the shop there is a small pneumatic hammer on which tools are dressed. The shop is well equipped with light and heavy jib cranes to facilitate the handling of the work. It is also equipped throughout with oil furnaces. The blast is furnished from two high pressure direct connected electric

driven blowers, each one of ample capacity to handle the entire shop equipment. The shop is also equipped with sanitary closets and washrooms for the convenience of the men.

POWER PLANT.

The power house supplies steam, compressed air and electric current for the entire plant and is equipped to raise the pressure on the water mains in case of fire. There is no high pressure pump for hydraulic apparatus, however, as all machines operated by hydraulic power have individual motor drive. This arrangement was considered more satisfactory since it eliminated the necessity for a line of high-pressure piping, which is often troublesome to maintain. The boiler room has six Murray Iron Works water tube boilers of 400 h. p. each, equipped with Foster superheaters and Taylor underfeed stokers. Space has been provided for four additional boilers. A boiler pressure of 150 lb. is maintained and the steam is superheated to 500 deg. F. A 4,000-h. p. Webster Star open type feed water heater is installed on a platform in the boiler room and an Alberger condenser in the basement under the engineroom. A spray pond of 500,000 gal. capacity, located 75 ft. west of the power plant, is used in connection with condensing apparatus.

The coal is dumped into a hopper underneath the track and is carried by a chain bucket type elevator into a conveyor that delivers it into overhead bunkers, where the coal is measured before being fed to the mechanical stokers. The ashes are collected in hoppers under the furnaces and are dumped into an ash car which carries them to the elevator pit. The elevator raises them to an overhead ash bin from which they are dumped into the empty coal car. The smoke stack is of brick, 12 ft. in diameter and 150 ft. high. Forced draft is supplied by three blowers driven by steam engines. The boiler room equipment operates non-condensing to supply the steam for feed water heating.

The electric generating equipment consists of two 750 kw. General Electric high pressure turbo generators, producing three-phase current at 440 volts and 60 cycles. The turbines are of the bleeder type, so-called from the fact that steam for heating is drawn off at a pressure of 4 to 5 lb., after passing the first stage of the turbine. A vacuum of $27\frac{1}{2}$ in. of mercury is carried on the low pressure stage. To furnish direct current for the variable speed shop motors there are two 200-kw. motor generator sets, generating at 220 volts d. c. There is one steam turbine driven and one motor driven exciter. A central switch board is installed on the west wall of the engine room and an instrument board for the boilers is located on the east wall. These carry a very complete equipment of pressure and temperature gages and draft gages and also continuous CO₂ recorder for each boiler. A Venturi meter is used for checking the amount of water evaporated by the boilers.

There are two air compressors in the turbine room both operating at a pressure of 110 lb. per sq. in. One is an Ingersoll compound type of 1,350 cu. ft. per minute capacity, taken from the old power house. The other is a Laidlaw condensing cross compound high duty compressor, with a capacity of 3,650 cu. ft. of free air at 110 R. P. M. The fire pump is a Fairbanks-Morse, 18 in. by 10 in. by 12 in. underwriters pump having a capacity of 1,000 gal. per minute. The steam, air and electric lines are carried from the power house to the shop in a concrete tunnel.

The engine room is equipped with a ten-ton traveling hand crane which spans the whole width of the building. This crane is used to facilitate handling or repairs to equipment.

BOILER SHOP.

The boiler shop is located in the building formerly used as the machine and erecting shop. The boilers are placed on the south side, which is equipped with overhead cranes

across the three longitudinal tracks. The machines are on the north side and are served by a monorail floor crane. The west end of the machine department is devoted to heavy plate work. Here are located the laying out table, bending rolls and flange fire, as well as the heavy punches and shears. At the center of the north wall is the office and tool room. In the space east of this the light machines, such as bolt cutters, lathes and small drill presses are located. Some of the tank work is being handled in the boiler shop, but eventually all the tender tank and truck work will be taken care of in the south half of the old boiler shop, just west of the present boiler shop.

FLUE SHOP.

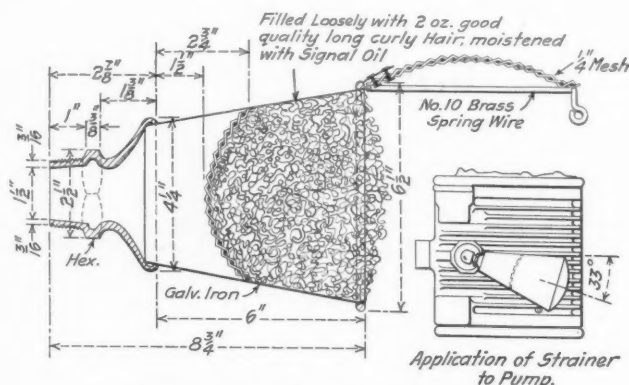
A unique arrangement of machines and tracks is used in the department where the tubes and flues are repaired. The layout of the shop is shown in the illustration below. Small flues after being removed from the boiler are loaded on push cars and enter the shop on the north track. The back end is cut off square and the flue is run through one of the Otto cleaners to remove the scale. As the tubes pass out from the cleaners they are placed on another push car. The clean tubes go down the track to the second turn table and are set on one of two diagonal tracks leading from it. Adjoining each of these tracks is the equipment necessary for applying safe ends, consisting of a small oil furnace, a hot saw and tube expander, a welding furnace and a welder and swedger. The flues pass through the furnaces and machines and when completed are placed on push cars on one of the diagonal tracks leading to the transverse track on the south side. The front ends of the tubes are heated with an oil burner to anneal them and they are cut to length and sent to the erecting shop to be reappplied.

Superheater flues are handled in a similar manner. The push cars enter the shop by the center track. The flues are cleaned and the back end is cut off, and the car is then set on the diagonal track next to the furnace. The safe end is inserted in the furnace but not welded, being swedged down to enter the flue for a distance of about one inch and welded to the flue with the oxy-acetylene torch. After the flues have had safe ends welded on they are cut to length and tested and are then annealed and put back in the boiler.

AIR PUMP STRAINER

BY E. A. M.

A simple air pump strainer, much more effective than the ordinary type which has so long been used, is shown in the drawing. In making it the casting from the old type strainer



A Simple Curled Hair Air Pump Strainer

is used, and in this is inserted a cone-shaped tube of sheet metal 6 in. long by $6\frac{1}{2}$ in. outside diameter at the large end. A concave screen of $\frac{1}{4}$ -in. wire mesh is inserted in the tube and soldered in place $2\frac{3}{4}$ in. from the inner end. The re-

mainder of the strainer is loosely filled with curled hair, about two ounces being required for this purpose. The outer end of the strainer is closed with a hinged lid of $\frac{1}{4}$ -in. wire mesh, soldered to a light brass wire frame. A slot in the side of the tube is provided to take the latch formed on the end of the wire lid frame. In order to provide sufficient spring for the proper operation of the latch, about two inches of the frame at the latch end of the wire is left unattached to the netting. The lid is hinged to the strainer at a point opposite the latch.

PRESENT CONDITION OF LOCOMOTIVES AND CARS

Notwithstanding the fact that the number of locomotives actually built for the use of the railways in the United States during the past year and the four preceding years has materially fallen behind the 10-year average of 1907 to 1917 inclusive, and that there was an acute shortage of power apparent at the close of 1917, there is at the present time very little evidence of a lack of sufficient power to meet immediate requirements. This does not mean, however, that there is no need for new power. Old locomotives have been kept in service at a sacrifice in operating efficiency to preclude a repetition of conditions existing last winter. The number of locomotives built each year during the above-mentioned 10-year period for domestic steam railroad use has averaged approximately 3,300. For the past five years, beginning with 1914, the railroads have fallen behind this figure by an average of about 1,300 locomotives each year, a decrease which can be accounted for only partially by the increase in tractive effort of the locomotives built during recent years.

Aside from the fact that the unprecedented weather conditions of last winter, so far have not been repeated this season, the present fortunate situation is broadly attributable to three factors: (1) In general the power of the country is

What has been accomplished in increased shop output will be evident from an inspection of Table I*, showing the condition of power for alternate weeks during a period of 18 weeks, for the months of August to November inclusive, which has been compiled from data collected by the equipment maintenance section of the Division of Operation of the Railroad Administration. For this period, which is practically one-third of the year, it is evident that the number of locomotives turned out of shops (including all engines out of service for repairs over 24 hours) is nearly 23 per cent greater than during the corresponding period of 1917, while the number of employees in the locomotive department has been approximately 9 per cent to 11 per cent greater than the number in service last year. Taking the country as a whole, the increase in output is more than accounted for by the increase in maintenance forces and the increase in working hours from the eight, nine and ten-hour days in effect in various parts of the country, to the 70-hour week, which was in effect on many roads from March to November 25. During the period covered by the table it also will be seen that there has been a gradual increase in the number of locomotives being repaired for other lines, the maximum shown being 284 during the first week in November.

Since November 25, when working time was reduced from 70 hours a week to a nine-hour day basis, followed on December 9 by a further reduction to an eight-hour day, there has been a decrease in output which has been felt more particularly in running repairs. The eight-hour day necessitates the employment of three shifts at engine terminals, with a consequent increase in supervision, where two shifts have heretofore been the rule. At present, in most cases practically the same number of men who have constituted the two shifts must be redivided into three. It will, of course, be possible gradually to build up these forces to overcome the present shortage as demobilization progresses. The power has been put in such good condition during the past sum-

TABLE I—WEEKLY SUMMARY OF THE CONDITION OF POWER ON THE RAILROADS OPERATED BY THE UNITED STATES RAILROAD ADMINISTRATION

Week ending	Number of locomotives			Per cent of locomotives out of service for over 24 hours	Number of locomotives turned out of shops			Number of locomotives		Number of employees in locomotive department		
	On lines	Serviceable	In or awaiting shops		1918	1917	Increase	Being repaired for other lines	Stored serviceable	1918	1917	Increase
August 3.....	62,764	53,665	9,999	14.4	5,329	4,462	867	190	924	261,915	241,104	20,811
August 17.....	62,740	53,398	9,342	14.8	5,260	4,337	923	177	708	262,056	240,615	21,441
August 31.....	62,908	53,932	8,974	14.2	5,828	4,940	888	194	848	264,349	241,845	22,504
September 14.....	63,119	53,774	9,345	14.8	5,686	4,507	1,179	199	994	273,752	245,996	27,756
September 28.....	63,126	53,987	9,139	14.4	6,083	4,806	1,277	236	913	275,326	247,533	27,793
October 12.....	63,162	53,874	9,288	14.7	5,576	4,599	977	245	901	270,287	249,543	20,744
October 26.....	63,247	53,711	9,536	15.0	5,807	4,723	1,084	274	875	271,554	250,195	21,359
November 9.....	63,269	53,357	9,912	15.6	5,791	4,636	1,155	284	878	276,837	253,066	23,771
November 30.....	63,418	53,641	9,777	15.4	6,317	5,054	1,263	259	1,119	281,384	253,788	27,596

in much better condition now than at the beginning of any winter for several years past; (2) the application of economy and capacity increasing devices to existing equipment has increased the effectiveness for service of a large number of locomotives, and, (3) there are now retained in service many locomotives which, if new power were available, would and could economically be scrapped.

LOCOMOTIVES IN GOOD CONDITION

That the condition of power is much better than it was last year is evidenced by the fact that for several months past there have constantly been stored in serviceable condition from 800 to 1,000 locomotives, over half of them on the eastern roads, where extraordinary demands are most apt to arise. This improvement has been made possible by the increased working hours which have been in effect since last spring, the decrease in labor turnover during the latter part of the year, and the increase in the number of men employed on locomotive maintenance. Both of the latter are the result of the wage increases put into effect by the Railroad Administration.

mer and fall that the reduction in back shop output following the reduced number of working hours on the whole need give little immediate concern.

Since 1914, the conditions which have restricted the buying of new power have directed attention to the possibilities for increasing the capacity of a large number of existing locomotives by the application of economy and capacity increasing devices, most important of which are the superheater, mechanical stoker and brick arch. During the past four years not less than 10,000 old locomotives have been equipped with one or more of these devices. In some cases the conversion has made unnecessary the purchase of a new class of power to perform the service which these engines were becoming unsuitable for, but which they are now capable of performing satisfactorily. In such cases each converted locomotive has saved the purchase of a new one, while in others the saving in new locomotives has been in proportion to the increase in capacity effected by the change, which

*A detail report of the condition of power by regions for the week ending September 28, 1918, was published in the *Railway Mechanical Engineer* for November, page 605.

conservatively would be between 10 and 20 per cent. It is evident that these 10,000 converted locomotives have had a material influence in preventing an acute power shortage.

While the use of obsolete locomotives, to scrap which authorization has been secured or is contemplated, may be effective in preventing an acute shortage of power, it can be justified only to meet an emergency. With such locomotives in service it cannot truly be said that there is no shortage of power. In the interest of economical operation it is now imperative that there be a heavy purchase of new power in order that the three or four years' accumulation of scrap power may be gotten off the lines.

NO IMPROVEMENT IN FREIGHT CAR CONDITIONS

Although there has been some improvement in the percentage of bad order cars in the course of the year, it is doubtful if there has been any real improvement in the condition of freight cars such as noted in connection with locomotives. In the first place the number of new cars delivered to the railroads during the past year was less than half the number which were placed in service during 1917, and is hardly large enough to take care of normal replacements. The extreme need of equipment during the past year has therefore led to the retaining in service of a large number of cars which should be and will be retired at the first opportunity. These cars, unlike old locomotives, cannot be kept in condition to remain in service without causing an undue proportion of failures, and the need of retirement is therefore greater than in the case of motive power.

Those roads which had practically completed extensive reinforcement programs prior to our entrance into the war still have their equipment in excellent condition. Many roads, however, were only instituting such programs or had only partially carried them out before the pooling of equipment took the rolling stock out of the control of the owning roads. In such cases there has been very little opportunity during the past year to continue the betterment program, the proportion of cars on home roads being so small as to very seriously slow up this work.

The pooling of equipment has also tended to decrease the output of running repairs. It is a comparatively simple matter to supply material for the repairing of home line cars at outlying points where mill facilities are not available. Considerable delay is inevitable, however, where a very large

way only can the greatest output be obtained for the labor expended. Air brake conditions have been notably poor during the past year. This is due in part to a lack of proper facilities for testing and repairing brake equipment, to the necessity for employing many inexperienced men on this class of maintenance, and in part to a shortage of material.

TABLE III—PERCENTAGE OF BAD ORDER CARS BY REGIONS

Week	Oct. 19	Oct. 26	Nov. 2	Nov. 9	Nov. 16	Nov. 23
Eastern	6.3	6.4	6.2	6.3	6.1	6.1
Allegheny	7.1	7.1	7.1	7.0	6.7	6.4
Pocahontas	5.9	6.9	5.8	5.6	5.6	5.1
Southern	4.4	4.8	4.5	4.7	4.8	4.4
Central Western	5.0	4.9	4.7	4.8	4.8	4.7
South Western	3.1	3.1	2.9	2.9	2.8	2.8
North Western	5.7	5.4	5.4	5.2	5.3	5.2
All regions	5.7	5.7	5.6	5.6	5.5	5.3

way only can the greatest output be obtained for the labor expended.

Air brake conditions have been notably poor during the past year. This is due in part to a lack of proper facilities for testing and repairing brake equipment, to the necessity for employing many inexperienced men on this class of maintenance, and in part to a shortage of material.

EFFICIENCY OF OXY-ACETYLENE WELDS.—It has been proved in tests on boiler plate that the average oxy-acetylene weld has an efficiency in the neighborhood of 70 per cent, although tests have been made in which the efficiency has run much higher. This would be a fair comparison with a lap-double seam of the ordinary 44,000 lb. shear of rivets, using a tensile strength of 55,000 lb. for the plate.—*The Engineer, London.*

RECORD CLAIMED FOR OXY-ACETYLENE TORCH CUTTING OUT RIVETS.—An operator employed by the Submarine Boat

TABLE II—WEEKLY REPORTS OF CAR CONDITIONS FOR ALL REGIONS

Week ending	Oct. 19	Oct. 26	Nov. 2	Nov. 9	Nov. 16	Nov. 23
Number of roads reporting	139	139	138	139	139	139
Total revenue cars	2,478,704	2,441,111	2,434,255	2,437,344	2,430,606	2,447,922
Bad order cars—1918	140,328	139,548	135,462	134,874	132,853	130,048
Bad order cars—1917	131,036	132,501	128,957	129,414	124,162	123,056
Heavy repairs—1918	82,459	82,078	79,559	79,198	77,966	78,941
Light repairs—1918	57,869	57,470	55,903	55,676	54,887	51,107
Percentage of bad order cars	5.7	5.7	5.6	5.6	5.5	5.3
Average number of bad order cars repaired per working day	86,486	83,279	83,328	83,469	82,274	82,805
Heavy repairs	9,332	8,871	8,578	8,797	8,173	8,209
Light repairs	77,154	74,408	74,750	74,672	74,101	74,596
Number of cars transferred to other shops	5,075	626	589	253	485	524
Number of employees—1918	140,021	138,703	158,959	142,500	141,540	143,169
Number of employees—1917	118,758	123,156	124,256	124,521	123,966	124,319
Number of cars damaged in trains	13,605	13,060	12,446	12,364	12,255	12,668
Cost of labor	\$126,630	\$121,275	\$90,464	\$122,463	\$128,925	\$135,887
Cost of material	\$154,708	\$151,476	\$170,532	\$162,818	\$179,972	\$182,005
Number of cars damaged in yards	5,264	4,868	5,267	5,275	5,159	5,242
Cost of labor	\$54,308	\$46,823	\$53,492	\$49,959	\$50,886	\$52,406
Cost of material	\$76,589	\$61,135	\$68,072	\$66,920	\$93,720	\$70,987
Cars held to be dismantled	5,584	7,211	6,920	6,823	6,646	6,640

percentage of the cars on the repair tracks belong to foreign lines, each requiring more or less special material.

The destruction of the incentive of the pieceworker following the failure to adjust the piecework wage differential to correspond to the increase in hourly rates, has had a much more marked effect in reducing the output in the car department than it has in the locomotive department.

The effect of these adverse conditions is not reflected in the percentage of bad order cars, which has been maintained

Corporation, Newark, N. J., claims a record, which was witnessed, timed and sworn to, of having cut out with his oxy-acetylene torch 123 3-inch countersunk rivets from an oil tank cover in 55 minutes. The work was so well done that the rivets came out with one stroke of the maul and punch.—*American Machinist.*

*For tables showing car conditions since the middle of July, see the *Railway Mechanical Engineer* for November, page 614, and December, page 656.

OUR RAILWAY WAR FORCES ABROAD

An Account of the Problems Encountered in France and the Shop Facilities for Erecting Equipment

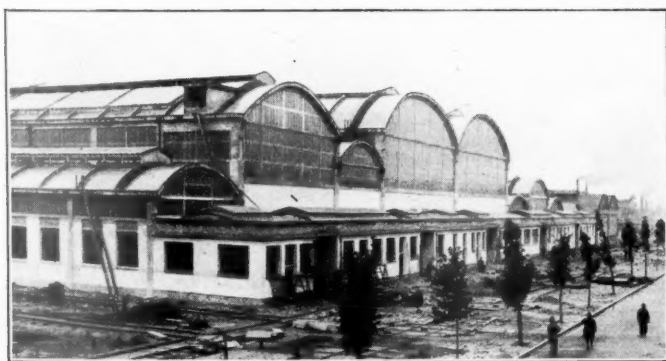
THE January 3 issue of Railway Age contains a signed article by Samuel O. Dunn, editor of that paper, which gives the first account of what the Transportation Department of the A. E. F. has done since America entered the war. Mr. Dunn, who has just returned from England and France, was the first American press representative to visit Tours, the headquarters of the Transportation Corps, since the signing of the armistice. He was given full access to all sources of information as to what has been accomplished by



Repairing Locomotives at Nevers

our American railway men. The following, which is of particular interest to our readers, is taken from that article:

When the United States entered the war in April, 1917, the officers and employees of American railways knew extremely little—in fact, practically all of them knew next to nothing—about the way in which the railways of Europe were constructed, equipped and operated. Even as late as July, 1917, the transportation department was practically non-existent. One year later—in June, 1918—it had a personnel of 1,300 officers and 30,000 men, was operating



Locomotive Shops at Nevers

through eleven French ports, and over an extensive system of railways and inland waterways. It was running exclusively American trains, the first train which was exclusively American in equipment and personnel having been run on July 1, 1918, from Gievre to Nevers, a distance of 83 miles. When the armistice was signed, in November, 1918, the American Transportation Corps had a personnel of 1,970 officers and 53,136 enlisted men. In addition, 553 officers and 21,452 men were attached to it for duty, making a total personnel of 2,523 officers and 73,588 men.

What our railway men have done is to take over the operation, and maintain and enlarge the facilities of existing

French railways to the extent necessary, first, to move our own armies and supplies to the front, and, second, to enable the French army to continue to carry on its part of the struggle with unimpaired energy and effectiveness. In order to enable the French railways to handle the vast additional traffic, it was necessary greatly to enlarge the facilities of the railways by building second, third and fourth tracks in some places; by building cut-offs in other places; by constructing numerous large yards and vast storehouses; by building shops to erect and maintain locomotives and cars, and by importing and putting in service large quantities of railway equipment and materials. Over 300 large construction projects (to be exact 316) were undertaken for the Transportation Corps. The total number of miles of new trackage actually built was 937, and the number of cars shipped from the United States knocked down and erected in France up to December 12, was 15,068. The number of locomotives from the United States put in service by our military forces in France was 1,105. Up to December 12 the complete record



Locomotive Repair Shop at Nevers

of the Transportation Corps with respect to the ordering, acquisition and erection of locomotives and cars was as follows:

	Locomotives			Freight cars		
	From U. S.	Other sources	Total	From U. S.	Other sources	Total
No. ordered	1,600	425	2,025	30,000	1,040	31,040
On sea	34	...	34	400	...	400
At port	139	...	139	747	...	747
At shop for erection...	19	63	82	1,238	...	1,238
Erected today (Dec. 12)	8	...	8	80	...	80
Erected to date	1,105	336	1,441	15,068	988	16,056

The magnitude of the work which the Transportation Corps has done is indicated, although only partially indicated, by the tonnage of supplies and the number of soldiers it has handled. Between June 1, 1917, and November 30, 1918, the total tonnage of supplies moved for the American Expeditionary Forces was 6,547,621 tons. What was accomplished is much better indicated by the increase in the tonnage handled per month and per day. In June, 1917, the tonnage handled was 24,524, or 817 tons per day, while in November, 1918, the tonnage handled was 920,972, or 30,699 tons per day. Plans had been made and were being carried out for providing a transportation capacity of 101,000 tons a day by June, 1919, if the war lasted until then. In the eighteen months from June, 1917, to November, 1918, inclusive, the number of troops transported into France was 1,865,440, and the number of animals, 53,117.

In the early part of August, 1917, General Pershing estab-

lished the principle that there must at all times be kept on hand in France 90 days' supplies of all kinds for our troops. Forty-five days' supply must be available at base ports; 30 days' supply at intermediate storage points, and 15 days' supply at advance storage points, which were to be 50 or 60 miles from the front.

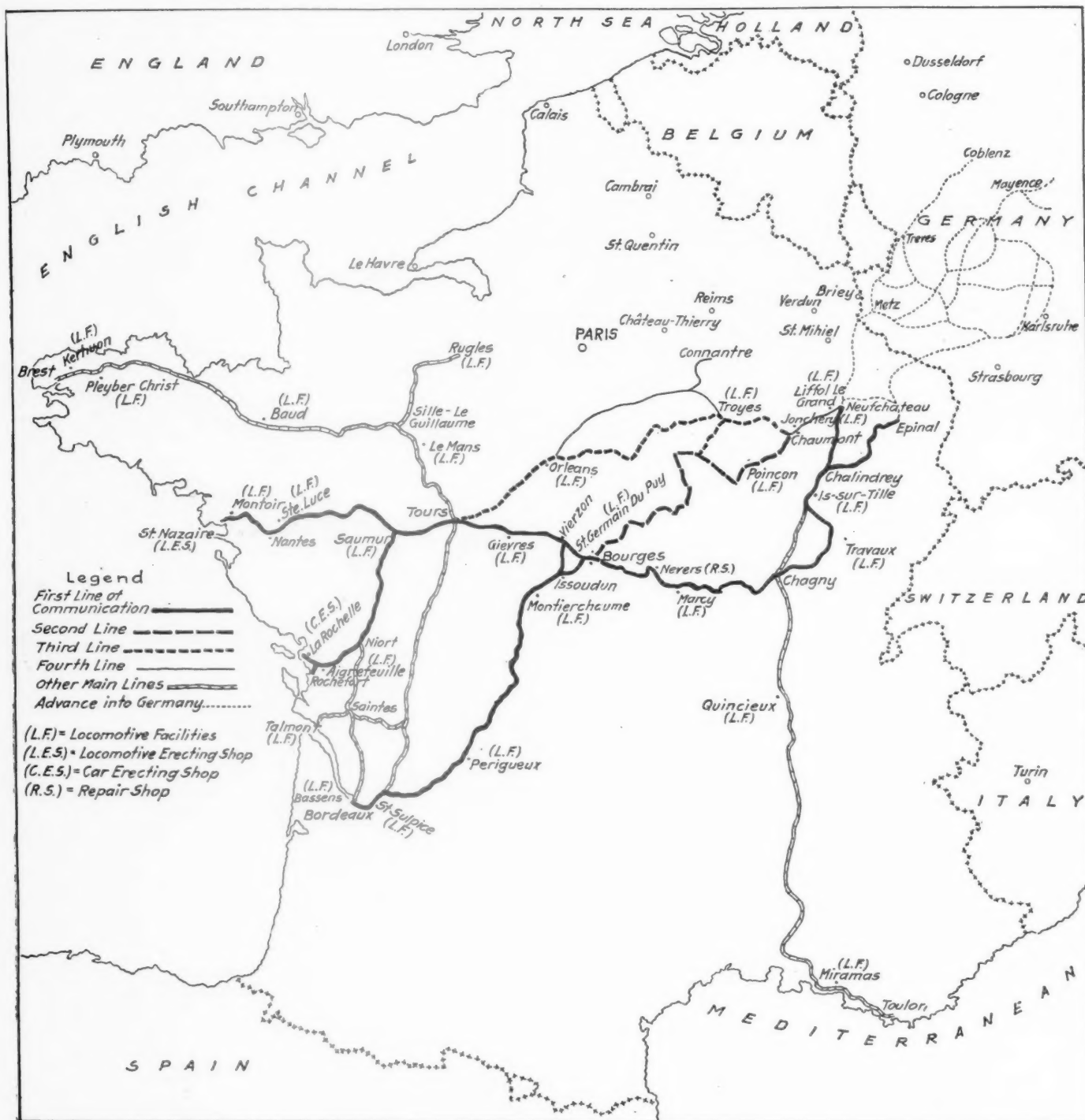
It was originally estimated that, on the average, there would have to be provided and transported 100 pounds of supplies daily for every American soldier in France. Ex-

of supplies which had to be furnished them increased by leaps and bounds, it became necessary rapidly to increase the number of ports used and greatly to enlarge the facilities of many of them. Five entire groups of ports finally were used. These were as follows:

Channel Group.—Le Havre, Fecamp, Hornfleur, Rouen, Cherbourg, St. Malo, Granville.

Brest Group.—Brest, Lorient, St. Brieuc.

Loire River Group.—St. Nazaire, Montoir, Donges, Usine



Lines of Communication, American Expeditionary Forces. Light Dotted Lines Show Advance Into Germany

perience showed that this estimate was much too large, and later ones were based on an average requirement of 50 pounds per day per man. The actual consumption, after the army had become large, was about 40 pounds per man per day.

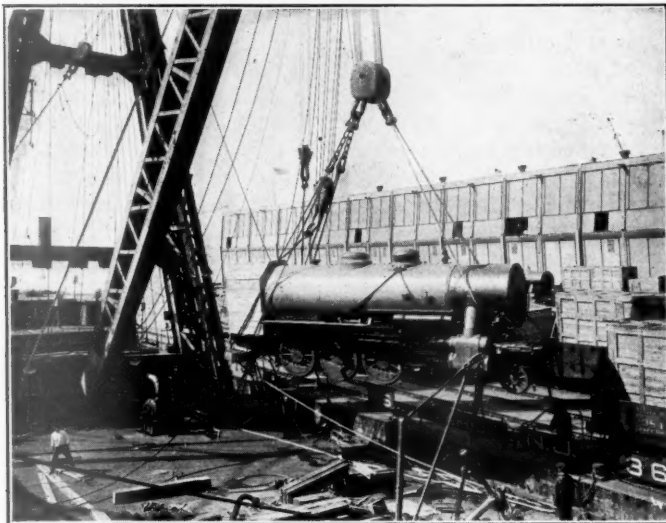
As the number of Americans in France and the amount

Brulee, Nantes, Les Sables d'Alone, La Pallice, Rochefort, La Rochelle, Ponnay-Charente, Marans.

Gironde River Group.—Bordeaux, Pauillac, Blazefort, St. Loubes, American Bassens, French Bassens, St. Sulpice, St. Pardon, Bayonne.

Mediterranean Group.—Marseilles, Toulon, Cete.

The principal dock project was at American Bassens, near Bordeaux. The docks at this point consist of 10 berths of 410 feet each, served by four tracks along the front of the docks. Electric gantry cranes are used for unloading cargoes from ships and placing the supplies on cars. Immediately back of the docks are classification yards and warehouses. There is at present a covered storage capacity of 121,984 square feet and open storage capacity of 262,170 square feet.



Hoisting Locomotive from Lighter to Ship

The tonnage unloaded at the ports in November was divided among the various classes of supplies as follows:

Supplies	Tonnage	Per cent of total
Coal	207,644	22.55
Forage	68,154	7.40
Foods	177,791	19.30
Clothing	9,451	1.03
Oil	23,629	2.51
Other quartermasters' supplies	63,657	6.91
Transportation materials	89,721	9.74
Motor transportation	50,096	5.44
Engineering supplies	75,272	8.17
Ordnance	64,195	6.97
Medical	10,973	1.19
Signal Corps	3,114	.34
Air Service	9,166	1.00
Gas Service	2,883	.31
Troop property	993	.11
Red Cross	3,765	.30
Y. M. C. A.	2,148	.23
Naval	1,780	.19
Steel billets	54,379	5.91
Miscellaneous	3,161	.34
Totals	920,972	100.00

"Ordnance" in the above classification embraces munitions of all kinds; and it is a striking fact that ordnance constituted less than 7 per cent of the supplies transported. Of course, however, a vast work of transportation was carried on in the United States in handling the fuel and raw materials which were used in the manufacture of the ordnance which ultimately formed so small a part of the supplies unloaded and transported in France.

CAR AND LOCOMOTIVE SHOP FACILITIES

Besides providing facilities for taking care of both French and American equipment when it was in service, it was necessary for the American Transportation Department to provide shops for getting it ready to put into service after it was received in France. The erection of locomotives and cars from the United States and the repair of those in France and Belgium by our transportation forces were begun in December, 1917. From that time up to the middle of December, 1918, the shop troops erected 1,055 locomotives from the United States, 99 for the French, and inspected and overhauled 359 from Belgium. They had also repaired 1,423 French locomotives. Records for the same period showed that 14,302

cars from the United States and 975 from other sources were erected, and that 45,993 were repaired for the French.

The large locomotive shop, where most of the work on locomotives is done, is at St. Nazaire. Locomotives for overseas shipment are erected and tested in the United States and then knocked down or partially knocked down for shipment. The knocked down locomotives are crated in sixteen boxes, the largest of which weighs 33,000 pounds. The partially knocked down locomotives are complete except rods, cab, stack, piping and odd fittings.

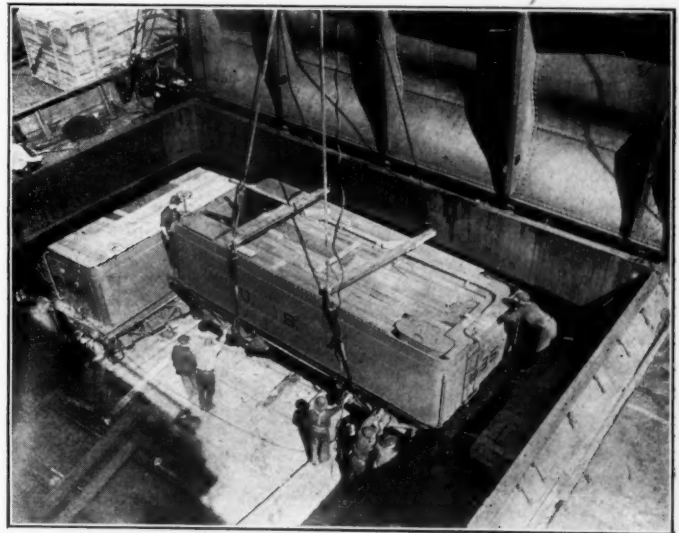
Arrangements were made to rent ten locomotive emplacements in Shop No. 1 from the Societe Anonyme des Ateliers et Chantiers de la Loire, nine emplacements in Shop No. 2 from the Societe Anonyme des Chantiers et Ateliers de Saint Nazaire (Penhouet) and the necessary storage and shifting tracks, all the above being located on the Bassin de Penhouet at St. Nazaire.

The main storage tracks located at Shop No. 1 include 14,600 feet of shifting and storage tracks and embrace 54,500 square feet of locomotive box storage. At Shop No. 2 the yard includes only 2,080 feet of track with no box storage, this yard being used principally for shifting.

The locomotive boxes are unloaded from the vessels by use of the French Titan cranes, loaded on flat cars and shifted to the locomotive box storage yard, unloaded by a 35-ton locomotive crane, and sorted out into complete locomotives, or held until the complete sixteen boxes are available. When sorted properly they are again loaded on flat cars, seven cars to a locomotive, and shifted either to Shop No. 1, close at hand, or Shop No. 2.

The locomotives under erection are handled in the French shops by two 100-ton electric cranes and are erected in proper sequence, that is, the drivers are placed, then the frames, the boiler, etc., until the locomotive is completed and ready to be sent to Montoir engine facilities to be tested.

The first locomotive was turned out at St. Nazaire shops October 27, 1917. Since that time, up to and including December 12, 1918, 1,032 locomotives have been completed.



Locomotive Tenders in Hold of Ship

This does not include 30 smaller type saddle tank locomotives completed at Rennes. The maximum daily output was obtained on September 6, when 14 locomotives were completed, this number consisting of seven partially erected type and seven knocked down type. The maximum weekly total was obtained during the week September 1 to 7, 1918, and was 69 locomotives. This number included 39 partially erected type and 29 knocked down type, and one saddle tank locomotive. The maximum monthly total was obtained in

September, 1918, and was 215 locomotives, 77 partially erected, 137 knocked down, and one saddle tank.

It is estimated that erecting shops No. 1 and No. 2 are capable of an output of 300 locomotives per month, 200 knocked down, and 100 partially erected. This capacity was never realized, as the locomotives were not received from the States in sufficient numbers, or were held up in ports.

When it was first proposed by the Transportation Department that locomotives should be shipped to Europe only partially knocked down, the Shipbuilding Board protested upon the ground that no ships were in existence which could stand up under the strain of such an immense concerted load. But boats were found which would stand up; and as many as 12 to 15 partially knocked down locomotives, together with their tenders, have been shipped to Europe in a single ship. This method of shipment has saved time and labor on both sides of the Atlantic, but especially after the engines have arrived in Europe. Gantry cranes which have been erected both at Bordeaux and St. Nazaire, have been used in transferring locomotives from the ships to the docks.

The large car erecting shops are at La Rochelle. These shops cover an approximate total area of 1,453,000 square feet. The buildings utilize an area of approximately 157,000 square feet. There are 34,325 feet, or about $6\frac{1}{2}$ miles of track, which include two sets of erecting tracks, four sets of unloading tracks, one locomotive and crane repair track and three tracks for painting.

An erecting set comprises six tracks spaced at 17 feet, 58 feet, 30 feet, 58 feet and 17 foot centers. The two outside tracks at each side are crane and unloading tracks. The two middle tracks are the erecting track and crane track. The erecting track is covered for its entire length of approximately

1,300 feet and is divided into sections, according to the phases of construction, as follows: 200 feet, truck storage and erection; 450 feet, erection and riveting; 180 feet, flooring; 300 feet for side and end lining, and 220 feet for roofing. The painting facilities consist of three tracks, each 1,000 feet long, which were never covered as originally planned.

The 58-foot intervals between tracks, at the first approach to the plant proper, are used for storage of car boxes, but further along the various buildings are placed in this space. The buildings included are the power house, offices, shop buildings, waste sheds, store houses, machine and blacksmith shops and quarters.

Car parts are received from the United States crated in 100-car lots. The crates are sorted and stored until the parts for a 100-car lot are on hand. Erection starts with the assembling of trucks, which are then moved along the track to the erection position, where a frame, to which the outside fittings have been previously riveted, is placed on the trucks by two 15-ton locomotive cranes. The car then passes through the various phases of construction, each operation comprising a phase, being completed as nearly as possible at the same time, so that no delay occurs.

The first car was turned out at La Rochelle shop February 26, 1918. Since that time, up to and including December 11, 1918, 14,830 cars have been completed. The maximum daily output was obtained on September 26, 1918, when 150 cars were completed. The maximum weekly total was obtained during the week September 22 to 29, 1918, and was 700 cars. The maximum monthly total, obtained in September, 1918, was 2,370 cars. These totals include cars of all types, that is, flat, box, low and high side gondolas, refrigerator and Roger ballast cars.

SHOP LABOR SITUATION IN 1918

Year Marked by Wage Advances and Decreases in Unit Production; Supply of Labor Now Improving

DURING the year 1918 changes took place in the labor situation that were little short of revolutionary. To understand the situation during the past year, it is necessary to look back as far as 1915 and 1916. In those years the industries in the Eastern states turned a great deal of their production over to war work, thus creating an unusual demand for men skilled in the mechanical trades. The wages paid in the war industries were higher than the prevailing scale and after a time affected the labor conditions on the railroads. Some of the most highly skilled mechanics were drawn away from railroad work by the prospect of higher remuneration and those remaining in the shops became dissatisfied with the relatively low rates of pay they received. The shortage of mechanics grew steadily worse during 1916 although in that year practically all the railroads increased the wages of the shopmen, the advances granted to the various craft in general varying from one to four cents an hour.

After the declaration of war there was a scramble among the mechanics to get into arsenals and navy yards and later in the year many of the men who had been employed on steel car work found lucrative positions in the ship yards. In June, 1917, the Railroad's War Board, realizing the necessity of maintaining the mechanical department forces, asked the Council of National Defense to define the policy with regard to the enlistment of machinists or other skilled railroad employees. It was felt at that time that there was danger of mechanics being drawn from the shops in such numbers as seriously to impair the efficiency of the railroads. The warning of the War Board was not heeded,

consequently many of the best mechanics left railroad service and their places were filled by men who had had but limited experience. As these men in turn developed into skilled mechanics they likewise left the railroads to take better paying positions in war industries. This resulted in a very large labor turnover.

ROADS ATTEMPT TO MAINTAIN SHOP FORCES.

The railroads tried as best they could to keep the mechanics in their employ, and during 1917 granted numerous wage advances, ranging from two to eight and one-half cents an hour. One of the principal increases was that put into effect in the Southeast. According to a decision rendered by Secretary of Labor W. B. Wilson, on August 24, 1917, the shopmen in this territory received wage advances of six and one-half to eight and one-half cents an hour. The rates of pay for machinists, boilermakers and blacksmiths with the advances, ranged from 45 to 52 cents an hour. It is interesting to note that the wage increases granted in 1917 were in general higher on Western roads than on Eastern roads, in spite of the fact that the greatest shortage of mechanics was in the East. This was no doubt due to the fact that the Eastern roads had experienced serious losses in net revenues and being denied an increase in freight rates were not financially able to pay higher wages.

The shortage of mechanics caused discipline in the shops to slacken. The men became indifferent about their work, and production decreased very considerably. The percentage of men absenting themselves from work became very

high and to counteract this tendency some roads inaugurated the practice of giving bonuses to men who were absent not more than two or three days during the month. The attempts to keep mechanics in the shops by increasing the wages did not have the desired results, consequently railroads in all sections of the country began to train women to do light work, both skilled and unskilled.

One of the factors that lowered the efficiency of the shops was the inadequate compensation the foremen received. Their earnings were often less than the average wages of the men under them, and with such conditions prevailing, it was difficult to secure competent men for supervisory positions. In fact, many foremen gave up their places and returned to work at their trade.

As the shortage of labor became more pronounced, the demands for wage increases grew more frequent. In December, 1917, the federated shop crafts on the Middle Western roads proposed rates of 62½ cents an hour for the locomotive shop crafts, 50 to 56 cents for carmen, and 44 cents for helpers, no increase to be less than 10 cents an hour. This tentative schedule was submitted to the members of the unions for their approval, but before the demands were presented to the roads, President Wilson assumed control of the transportation systems.

LABOR CONDITIONS AT THE BEGINNING OF FEDERAL CONTROL.

Such in general was the labor situation when the roads were taken over by the Government. The developments up to that time indicated clearly the conditions that would have to be met as long as the war lasted. The traffic was certain to be abnormally heavy, requiring motive power and rolling stock in good working order to handle it efficiently. The supply of labor instead of increasing, would decrease as more and more men entered military service. The problem therefore, was to secure increased output in spite of the constant depletion of the existing forces.

The absolute control over labor which the Government could exercise, made the problem less difficult for the Railroad Administration than it had been for the individual roads, and hope was expressed that the labor problem would be handled in a broad and thorough manner. However, the Railroad Administration has treated the labor question primarily as a *wage* problem and not as a *production* problem. The increased output required in the shops might have been secured through an increase in the production per man, either by working longer hours or by speeding up during the working period; or through an increase in the labor supply, by raising the wages sufficiently to attract labor from other fields, or by training women to fill those positions for which they are qualified. During the past year, the Director General and his staff have increased the hours of work and raised the wages, but they have made practically no effort to introduce women in railroad work and instead of placing a premium on high unit production, they have actually discouraged such measures by refusing to allow increases in piece work rates.

The wage problem was given consideration by Director General McAdoo soon after his appointment. A wage commission headed by Secretary of the Interior Franklin K. Lane, was appointed on January 18, to make recommendations for wage adjustments and on February 9 the Division of Labor was created with W. S. Carter as director. The first action that Mr. McAdoo took with regard to the labor situation in the mechanical department came in February. At that time he announced that the railroad shop employees, acting through A. O. Wharton, president of the railway department of the American Federation of Labor, had agreed that the hours of labor in the shops should be increased to 70 per week and that apprentices with three years' experience and helpers with five years' experience should be promoted to the rank of mechanic. It was also stipulated

that mechanics were not to be denied employment for any cause other than inability to perform the work.

WAGE ADVANCES FOR MECHANICAL DEPARTMENT EMPLOYEES.

Director General McAdoo's promise to grant adequate wages was quite as effective in holding the men as any actual increase could have been, and comparatively few mechanics left railroad service during the early part of the past year. On May 25, the findings of the Railroad Wage Commission were made public. The commission recommended increases on a sliding scale ranging from \$20 a month for those who, in December, 1915, received \$46 or less, to \$1 for those receiving \$249. The Director General modified these recommendations and established a minimum rate of 55 cents an hour for machinists, boilermakers and blacksmiths. The employees of the mechanical department were not satisfied with the increases awarded by the provisions of General Order No. 27, principally because it took no account of the wage advances secured during 1916 and 1917. The disapproval of the findings of the commission was so strong that strikes took place in two shops. It was evident that the employees had expected to be awarded wages commensurate with those paid to mechanics in war industries. In hearings before the Board of Wages and Working Conditions, the representatives of the shopmen's organization asked for a rate of 75 cents an hour for car and locomotive shop men with over four years' experience and 56¼ cents for car men with less than four years' experience. Supplement No. 4 to General Order No. 27, issued on July 24, established a minimum rate of 68 cents an hour for mechanics, boilermakers, blacksmiths, sheet metal workers, molders and first class electrical workers, 58 cents an hour for car men and second-class electrical workers, and 45 cents an hour for helpers. It provided also for foremen paid on an hourly basis a rate 5 cents higher than their respective craft, and an increase of \$40 a month for foremen paid on a monthly basis, with a minimum of \$155 and a maximum of \$250. For the sake of uniformity, all foremen were later placed on an hourly basis. The basic eight-hour day was established, and the increases were retroactive to January 1.

Other classes of labor in the shops were granted increased wages under the provisions of supplement No. 7, issued September 5, 1918, the minimum rates established being as follows: For stationary engineers, \$110 per month; for stationary firemen and power house oilers, \$90 a month; for locomotive boiler washers, 38 cents an hour; for power transfer and turntable operators, 33 cents an hour; for shop, roundhouse and storehouse laborers, 31 cents an hour, and for common labor 28 cents an hour. The rates specified in supplement No. 7 were not retroactive but were made effective September 1, 1918.

The increases in the wages resulting from the application of the new schedules, have been variously estimated at from 40 to 60 per cent. in the locomotive department, and from 40 to 90 per cent. in the car department. The increase would vary considerably in different shops, depending on the basis of payment previously in force. The supplements to General Order No. 27 made no provision for increases in the piece work prices, and this has resulted in the abolition of piece work in a large number of the shops.

EFFECTS OF HIGHER WAGES ON LABOR CONDITIONS.

In general the mechanical department employees were well pleased with the wages awarded by supplements Nos. 4 and 7. The migration of railroad shop employees to other industries practically ceased and many who had left railroad service returned to their former occupations. Director General McAdoo stated that he expected every railroad employee by faithful and efficient service to justify the large increases of pay granted to them. However, the evidence at hand indicates that this result was not secured. The shopmen were

given an opportunity to increase their earnings very materially, but instead of working steadily after the new rates went into effect, many worked only enough days in each month to earn a small amount in excess of what they formerly received. The percentage of absentees in the shops was in some instances as high as 30 per cent. and to find 20 to 25 per cent. "laying off" was by no means unusual. While piece work systems were not abolished, the earnings under existing piece work rates were in most cases only slightly higher, and in some cases even lower than the established minimum wage for mechanics. Consequently when the higher rates went into effect, there was no longer sufficient incentive for men to increase their production to a point where they would earn more than the guaranteed rate per hour. On the few roads where the rates earned on piece work were considerably higher than the present wages, the system is still in effect and the unit production has not fallen off appreciably. Where the incentive has been removed, however, the output has fallen very markedly. Records of the average earnings on roads which had piece work systems before and since the wage increases went into effect are available. On one typical road the data showed that whereas the men in the car department, under the old piece work system, earned an average of 45 cents an hour, they were now earning 35 cents an hour, but were of course receiving the minimum rate of 58 cents an hour. On another road it was found that the output was but 60 per cent. as much per man as formerly, and 40 per cent. as much work was being turned out per dollar as before. These are by no means extreme instances, as in some cases the records for whole shops show that the men's earnings have dropped to from 20 to 30 per cent. of what they had been while the work was being done at the piece rate. It is probably no exaggeration to say that in the shops where piece work has been eliminated the output per man has decreased 30 per cent. and the labor cost of doing the work has increased 50 per cent.

OVERTIME AND PRODUCTION.

The experience gained during the past year demonstrates plainly that increasing the hours does not increase the output in proportion. In general as much work was done in a ten-hour day as in a 13-hour day, and the officers of one road stated that they expected to secure practically the same output with the shops running 48 hours a week that was obtained when the men were working 70 hours a week. It should be stated, however, that the eight-hour day has not been received with favor particularly by the car men, and under this condition the normal production cannot be secured.

In considering the records of the shops, the fact must not be overlooked that supervising officers were working under unfavorable conditions. The foremen, as a class, were underpaid. Many had given up their positions to return to work at the trade, and this tendency became even more marked after the issuance of General Order No. 27. Had the foremen been granted salaries commensurate with their responsibilities, the labor situation would undoubtedly have been improved. The inadequate wages not only made it difficult to secure competent men for the supervising forces, it also resulted in the foremen losing authority, as where the workers received higher wages than the supervising forces they feel the foremen are their inferiors, and obey instructions grudgingly. It was not until the first of November that the supervising forces were granted adequate wage increases. While the final wage scales for the foremen were in general quite satisfactory, they came too late. The most trying times had passed, and the roads had lost the full production that might have been secured had the foremen been able to exercise complete authority in the management of the shops.

The effect of the Government's attitude toward labor has been clearly shown in the mechanical department. One of

the first significant changes was a marked increase in the number of men enrolled in labor organizations. Soon after the Railroad Administration announced that no distinction should be made between members or non-members of labor unions, the representatives of the American Federation of Labor sent organizers to the "open" shops. As a result of the activities of the federation, there is hardly a shop in the country in which a local lodge has not been formed. This movement has been furthered by the evident advantages of organized labor in enforcing its claims on the administration and by the widespread opinion among the workers that the organized crafts have been especially favored in the wage awards.

GOVERNMENT ATTITUDE TOWARD LABOR.

The removal of the power of determining wages from the officers of the individual roads had an unfortunate effect on discipline in the shops. The men became imbued with the belief that any favors they were to receive would be determined by the authorities at Washington and that the administration of discipline would likewise be governed by the central body. This resulted in flagrant cases of insubordination. Men refused to obey the orders of the foremen in the shops, denied the power of the supervising officers to discharge them, and whenever they were not satisfied with decisions in matters affecting wages or working conditions, carried the matter to Washington in the form of complaints or grievances. In general the men were inclined to give credit for all the benefits they received to the Railroad Administration, but placed all the blame for undesirable conditions on the local officers. The general effect of this situation on the morale of the workers can readily be appreciated.

SUPERVISORS TRY TO INCREASE PRODUCTION

Late in the year, the administration officers seem to have arrived at a realization that the men were not giving a fair day's work for a fair day's pay. Belated attempts were made to increase the production of the shops. The general supervisors of equipment visited a number of plants, and by personal appeal, endeavored to speed up the workers and restore discipline. These men have stated that the workers are not giving the Government the output which they had given to the railroads under private control, regardless of the fact that wages have been increased and working conditions improved. In one case following an unpopular reduction in the working hours, the men deliberately cut the output more than 50 per cent. The equipment inspectors have insisted that insubordination must cease, and that shopmen must obey their officers. This movement should result in better output in a short time under the present conditions.

Since the signing of the armistice the labor situation has undergone a rapid change. In the sections of the country where many war industries were located, there are now plenty of mechanics available. In other sections a slight shortage of skilled labor is reported. The working period in the shops has been reduced to eight hours per day, and where it is found that a single shift will not give the required output, the second shift is to be organized. This arrangement has been put in force in order to give employment to the maximum possible number of men during the reconstruction period. With the decrease in the demand for skilled labor there has come a change in the attitude of the workers. The unit production probably reached the low point during the last months of the year. During the coming months there should be a marked improvement in the morale and in the output of the shops.

GERMAN RAILWAY EQUIPMENT FOR FRANCE.—Press despatches state that on December 29 Germany would deliver to France 2,600 locomotives and 70,000 cars.

TWO MORE STANDARD LOCOMOTIVES

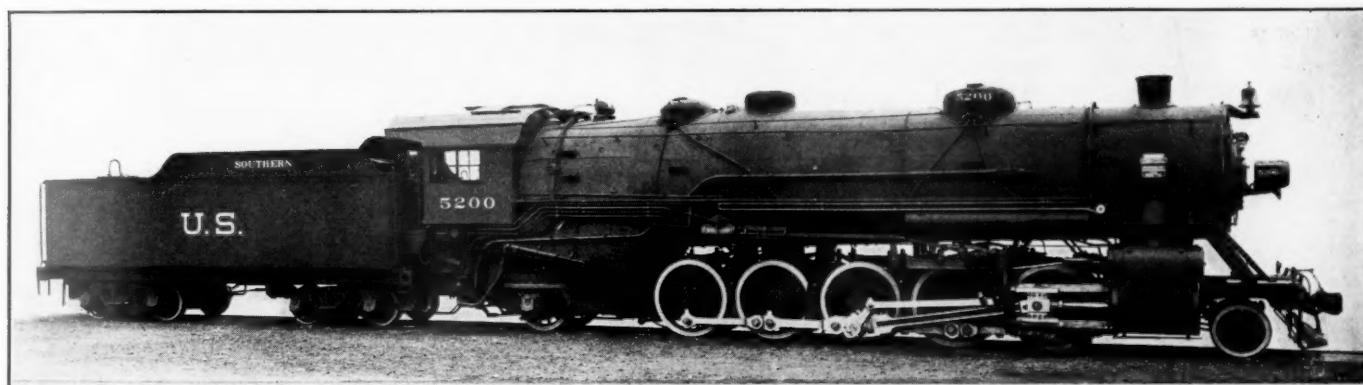
Heavy 4-8-2 and Light 2-10-2 Types Are Well Proportioned and Have Essentially the Same Boiler

THE FIRST LOCOMOTIVES of the United States Railroad Administration standard heavy Mountain type and light Santa Fe type have recently been delivered by the American Locomotive Company.

The boilers used on these two types are practically identical; the size of the shell, the number and diameter of tubes and flues and the principal firebox dimensions are the same. The principal difference between the two boilers is in the slope of the mudring, the height of the center line of the boiler on the Mountain type locomotive making possible the maintenance of a deeper backhead with less inclination of

dimensions of the standard 4-8-2 type locomotive with a few of the recently built locomotives of this type. It will be found that although the total weight of this locomotive is slightly less than that of the A. T. & S. F. locomotive,* the weight on the drivers is considerably higher, as is also the tractive effort, which exceeds that of any locomotive of this type previously built. It will also be observed that the cylinder stroke is longer than has usually been adopted for locomotives of this type, which accounts for the high starting tractive effort obtainable.

A similar comparison of Santa Fe types shows less of



The Standard Light 2-10-2 Type Locomotive

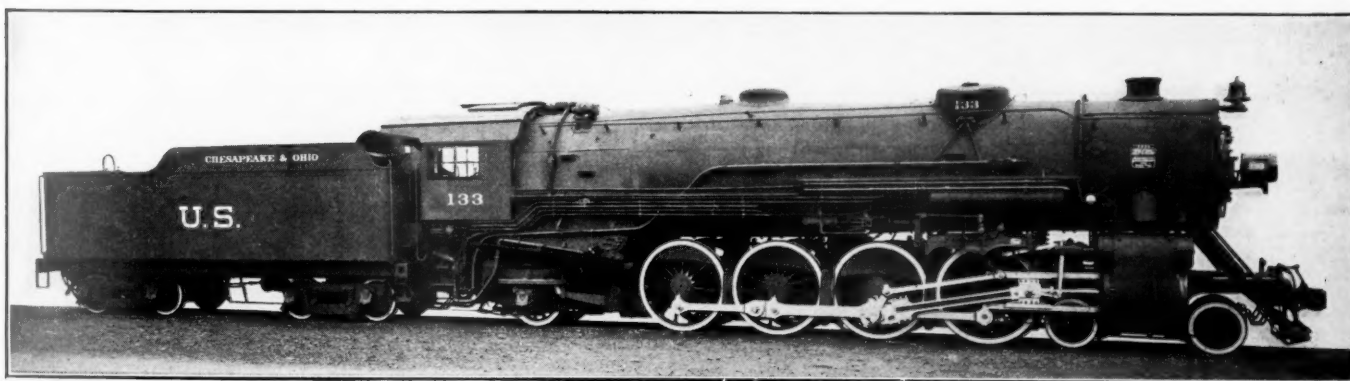
the grate than was necessary on the 2-10-2 type. The design of both types conforms closely in the details used to the other standard types which have already been built, and a considerable measure of interchangeability exists in the details of the various classes.

The boiler provides ample capacity in each case. Stating the relation between the boiler capacity and the cylinder demand on the basis of Cole's ratios, the Mountain type locomotive has practically a 100 per cent boiler, while the boiler

interest, as the comparison in order to be fair must be confined to locomotives of medium weight; the light 2-10-2 type is designed to keep within axle loads of 55,000 lb.

COMPARISON OF PRINCIPAL DIMENSIONS OF NOTABLE 4-8-2 TYPE LOCOMOTIVES

Road	U. S. Std.	Santa Fe	N. Y. C.	N. & W.
Builder	American	Baldwin	American	N. & W.
Year built	1918	1918	1916	1916
Tractive effort, lb.	58,000	54,000	50,000	57,000
Total weight, lb.	352,000	353,900	343,000	341,000
Weight on drivers, lb.	243,000	227,700	234,000	236,000
Cylinders, in.	28 by 30	28 by 28	28 by 28	29 by 28



The U. S. Standard Heavy Mountain Type Locomotive

for the Santa Fe type is equivalent to about 109 per cent. The design of the boiler itself is well balanced, both as to the ratio of tube length to diameter and the ratio of grate area to heating surface. The latter relation checks almost exactly with Cole's assumption of 120 lb. of coal per square foot of grate per hour at the maximum boiler output.

In the table is presented a comparison of the principal di-

Boiler pressure, lb. per sq. in.	200	200	185	200
Diameter of drivers, in.	69	69	69	70
Evaporating heating surface, sq. ft.	4,666	4,790	4,430	3,984
Superheating surface, sq. ft.	1,085	1,086	1,212	882
Grate area, sq. ft.	76.3	71.5	66.8	80.3

The tonnage rating charts for the two types were prepared by H. S. Vincent and are similar to those shown in the

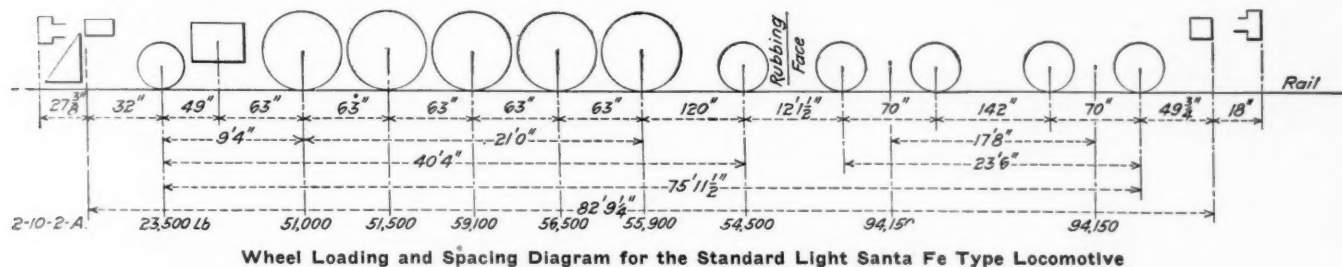
*See the *Railway Mechanical Engineer* for December, 1918, page 649.

2-10-2 type, both the light and heavy Mikado types and the eight-wheel switcher. The crosshead body, with the exception of the finish for the wrist pin fits, the front end main rod clearance and the piston rod fit is identical for the heavy Mountain type locomotive, both the light and heavy Mikado type locomotives and the eight-wheel switcher. The crosshead shoes are not interchangeable. The piston and rod used

interchange with those of this size used on both the light and heavy Mikado type locomotives.

The leading trucks on both locomotives are of the constant resistance type, while the trailing trucks are of the Cole-Scoville type, the journals in both cases being 9 in. in diameter by 14 in. in length.

The Baker valve gear is applied on the Mountain type lo-

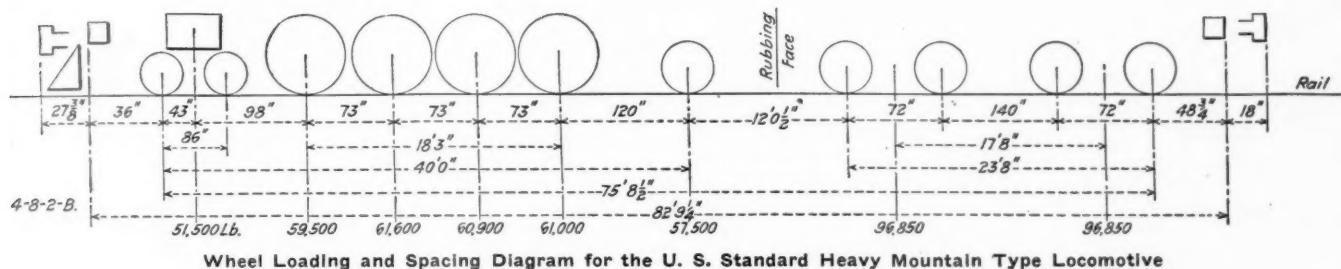


Wheel Loading and Spacing Diagram for the Standard Light Santa Fe Type Locomotive

on the light Santa Fe locomotive are identical with those used on the heavy Mikado type. Hunt-Spiller gun iron is used for piston and crosshead wearing shoes, piston and valve packing rings and cylinder and valve chamber bushings on both the Mountain and Santa Fe types. Paxton-

comotives while the Santa Fe type are fitted with the Southern valve gear. In both cases the valve motion is controlled by the Ragonnet power reverse gear.

Both locomotives are served by tenders carrying the standard 10,000-gal. tank mounted on Commonwealth cast steel

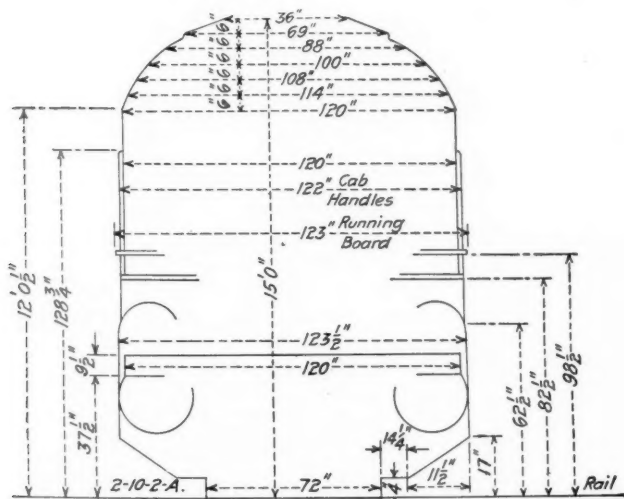


Wheel Loading and Spacing Diagram for the U. S. Standard Heavy Mountain Type Locomotive

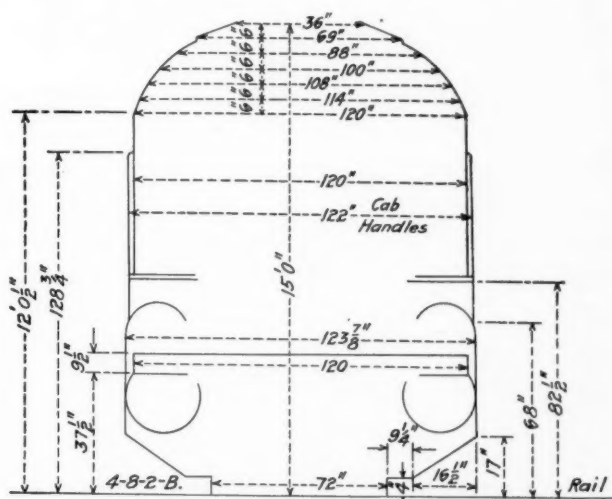
Mitchell metallic packing is used for the piston and valve rods on both types.

On both the light Santa Fe and the heavy Mountain types the main driving journals are 12 in. in diameter by 13 in. long. The other journals on the Mountain type are 11 in. in diameter by 13 in. long and the driving boxes for these axles

frames. The passenger tenders are fitted with equalized trucks having frames of the built-up type, while the trucks under the freight tender have cast steel side frames. In both cases the trucks are fitted with Woods roller side bearings. The connection between the engine and tender includes the Unit safety drawbar and Radial buffers, while



Clearance Diagram for the Light 2-10-2 Type



Clearance Diagram for the Heavy 4-8-2 Type

interchange with the main driving box for the light Mikado type locomotive, with the exception of slight differences in the finish of the crown brass, which is bored out 1/32 in. oversize for the Mountain type journals and 1/100 in. oversize for the main journals of the Mikado. The other journals on the Santa Fe type are 10 in. in diameter by 13 in. in length and the driving boxes used on these axles in-

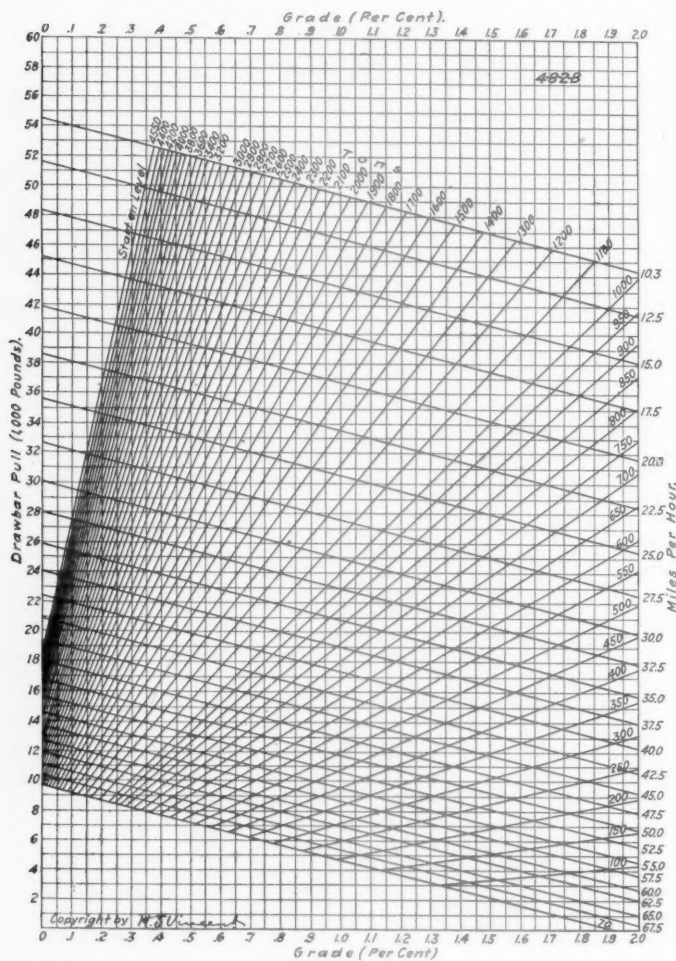
the rear ends of the tenders are fitted with Westinghouse D-3 type draft gear.

Among the specialties are Everlasting blow-off cocks on the 4-8-2 type, Murden blow-off cocks on the 2-10-2 type, Ashcroft and Ashton steam gages on the 4-8-2 and 2-10-2 types, respectively, Detroit six-feed six-pint lubricators on both types and Leslie steam heat equipment on the 4-8-2

type. Greenlaw flexible pipe couplings are used on the 4-8-2, while the 2-10-2 is fitted with Barco couplings.

The principal dimensions and data for both types are given in the clearance and wheel load diagrams, which were prepared by F. P. Pfahler, chief mechanical engineer, Division of Operation, United States Railroad Administration, and in the following table:

General Data		
	4-8-2	2-10-2
Gage	4 ft. 8½ in.	4 ft. 8½ in.
Service	Passenger	Freight
Fuel	Soft coal	Soft coal
Tractive effort	58,000 lb.	69,400 lb.
Weight in working order	352,000 lb.	352,000 lb.
Weight on drivers	243,000 lb.	274,000 lb.
Weight on leading truck	51,500 lb.	23,000 lb.
Weight on trailing truck	57,500 lb.	54,000 lb.
Weight of engine and tender in working order	547,500 lb.	540,300 lb.
Wheel base, driving	18 ft. 3 in.	21 ft.
Wheel base, total	40 ft. 0 in.	40 ft. 4 in.
Wheel base, engine and tender	75 ft. 8½ in.	76 ft. ½ in.
Ratios		
Weight on drivers ÷ tractive effort	4.2	3.9
Total weight ÷ tractive effort	6.1	5.1
Tractive effort × diam. drivers ÷ equivalent heating surface*	637.0	629.6
Equival't heat. surface* ÷ grate area	82.4	82.4
Firebox heating surface ÷ equivalent heating surface,* per cent.	5.9	5.9



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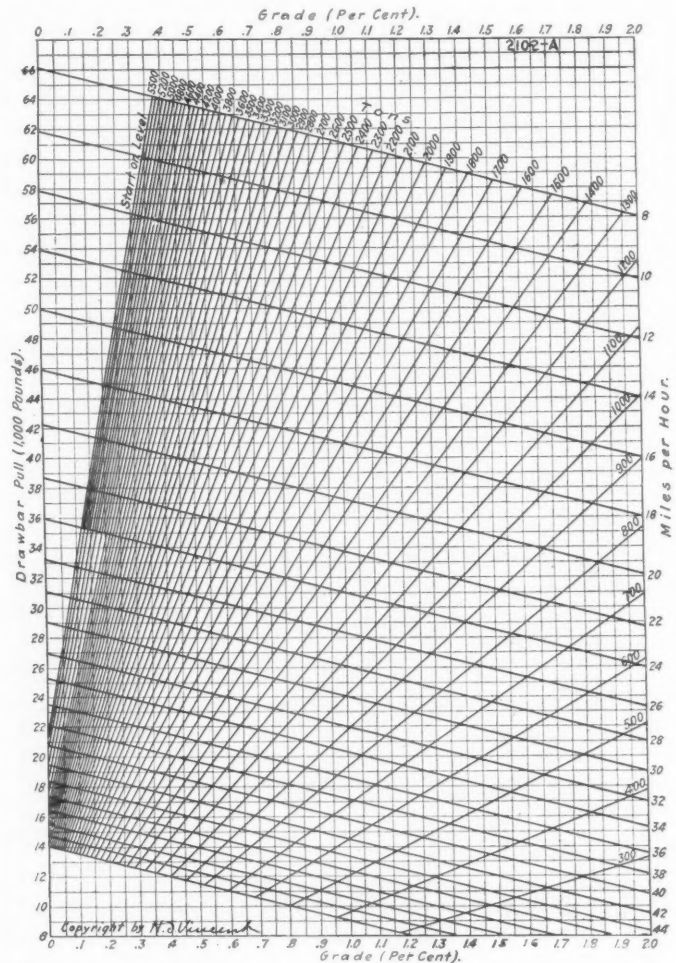
Tonnage Rating Chart for the U. S. R. A. Standard Heavy Mountain Type Locomotive

Weight on drivers ÷ equivalent heating surface*	38.7	43.6
Total weight ÷ equivalent heating surface*	56.0	56.0
Volume both cylinders	21.4 cu. ft.	21.2 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	293.9	296.3
Grate area ÷ vol. cylinders	3.6	3.6

Cylinders

Kind	Simple	Simple
Diameter and stroke	28 in. by 30 in.	27 in. by 32 in.

Valves		
Kind	Piston	Piston
Diameter	14 in.	14 in.
Wheels		
Driving, diameter over tires	69 in.	57 in.
Driving journals, main, diameter and length	12 in. by 13 in.	12 in. by 13 in.
Driving journals, others, diameter and length	11 in. by 13 in.	10 in. by 13 in.
Engine truck wheels, diameter	33 in.	33 in.
Engine truck, journals	6½ in. by 12 in.	6½ in. by 12 in.
Trailing truck wheels, diameter	43 in.	43 in.
Trailing truck, journals	9 in. by 14 in.	9 in. by 14 in.



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Tonnage Rating Chart for the U. S. R. A. Standard Light Santa Fe Type Locomotive

Boiler		
Style	Conical	Conical
Working pressure	200 lb. per sq. in.	200 lb. per sq. in.
Outside diameter of first ring	86 in.	86 in.
Firebox, length and width	114½ in. by 96¼ in.	114½ in. by 96¼ in.
Firebox plates, thickness—Sides, back and crown, ¾ in.; tube	½ in.	¾ in.; ½ in.
Firebox, water space—Front, 6 in.; sides and back	5 in.	6 in.; 5 in.
Tubes, number and outside diameter	247—2½ in.	247—2½ in.
Flues, number and outside diameter	45—5½ in.	45—5½ in.
Tubes and flues, length	20 ft. 6 in.	20 ft. 6 in.
Heating surface, tubes	2,970 sq. ft.	2,970 sq. ft.
Heating surface, flues	1,323 sq. ft.	1,323 sq. ft.
Heating surface, firebox	373 sq. ft.	373 sq. ft.
Heating surface, total	4,666 sq. ft.	4,666 sq. ft.
Superheater heating surface	1,085 sq. ft.	1,085 sq. ft.
Equivalent heating surface*	6,283 sq. ft.	6,283 sq. ft.
Grate area	76.3 sq. ft.	76.3 sq. ft.

Tender

Tank	Water bottom	Water bottom
Frame	Cast steel	Cast steel
Weight	193,700 lb.	188,300 lb.
Wheels, diameter	33 in.	33 in.
Journals, diameter and length	6 in. by 11 in.	6 in. by 11 in.
Water capacity	10,000 gal.	10,000 gal.
Coal capacity	16 tons	16 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

RAILROAD ADMINISTRATION NEWS

New Director General Not Named; Other Resignations; Circulars Issued from Washington and the Regions

AS this issue goes to press no successor to Mr. McAdoo has been named although Walker D. Hines appears to be the preferred candidate. Mr. Hines has been with the Railroad Administration since it was formed a year ago, having been formerly chairman of the Board of Directors of the Atchison, Topeka & Santa Fe. He is the most logical successor to Mr. McAdoo, having followed through the year's developments with him.

During the month Judge Robert S. Lovett, the head of the Division of Capital Expenditures, resigned to return, after two months' rest, to the Union Pacific as its president. On December 20, Carl R. Gray, director of the Division of Operation, tendered his resignation, to take effect January 15. Mr. McAdoo delayed this abdication of the director generalship until after he presented his plea for the five-year extension plan to Congress. He then expects to go to California with his family for a rest.

EMPLOYEES WANT MCADOO TO STAY

Mr. McAdoo has received hundreds of letters and telegrams expressing regret because of his resignation as director general of railroads and appreciation of the work he has accomplished, from all classes of railroad service, from employees to managers and corporation officers. The employees, however, are most expressive of their desire to retain him as boss and many of them have backed up their words by concrete evidence. In addition to the numerous offers to "chip in" toward an adequate salary, four employees of the St. Louis-San Francisco enclosed certified checks for \$1 each as a Christmas present.

The executive council of the railway department of the American Federation of Labor called on Mr. McAdoo on Saturday after his return from his southern trip, to present resolutions asking him to retain his office, and also another resolution, which was transmitted to the President, proposing legislation which would "provide a salary in keeping with the services rendered." The resolutions also protested against any plan to return the roads back to private control.

RAILROAD ADMINISTRATION NOT CANCELLING ORDERS

In reply to various inquiries that have reached Washington regarding rumors that the Railroad Administration had cancelled or was likely to cancel outstanding orders for equipment, officials of the Administration say that no cancellations have been made, except in the case of the recent orders for 600 locomotives, which were held up and then reinstated before the contracts were formally signed, and it is understood that none are proposed, although as reported last week an investigation was undertaken of the situation as to the outstanding car orders.

DIRECTOR GENERAL'S CHRISTMAS MESSAGE TO RAILROAD MEN

"Christmas this year will have a special significance to peoples everywhere. For the first time in four years the world is at peace and railroad men can be happy in the consciousness that they have contributed their full share to this result. I shall always remember the splendid way in which they applied themselves to the task of running the railroads at a time when their efficient operation was absolutely fundamental to the winning of the war. I am proud to have been associated with them in this great job.

"The railroads have not alone carried the tremendous burden thrown upon them by the war, but they are now in better shape than ever before in our history. For the coming winter

I have no fear of their ability to do the work required of them.

"And now, as I am about to sever my connections with the officers and employees of the railroads, I want to assure them of my deep regret at being forced to take this step. Among the happiest memories of my life will be those connected with my work as director general of railroads. I shall always cherish the friendships I have formed with railroad officers and employees, and I take this opportunity to assure them that although I shall no longer be their 'boss,' I shall always be their friend."

RULES FOR INSPECTING AND TESTING STATIONARY BOILERS

The Division of Operation has issued Mechanical Department Circular 11 dealing with the rules and instructions for the inspecting and testing of stationary boilers, as follows:

Rule 1—These rules shall apply to all steam boilers and their appurtenances operated by railroads under Federal control, except the boilers of locomotives or boilers used solely for heating which carry pressure not exceeding 15 pounds per square inch.

Rule 2—The chief mechanical officer of each railroad will be held responsible for the general design, construction, and inspection of all boilers covered by these rules. He must know that all inspections are made in accordance with the rules, and that the defects disclosed by any inspections are properly repaired before the boiler is returned to service.

Rule 3—The working pressure of each boiler shall be determined by the mechanical engineer, using the formula commonly used in determining safe working pressures, and after a thorough inspection and report by a competent inspector. The minimum factor of safety allowed shall be four.

In determining safe working pressure, the maximum allowable stress shall be 7,500 pounds per square inch for staybolts, and 9,000 pounds per square inch for round or rectangular braces supporting flat surfaces.

Rule 4—Each boiler shall be given a serial number by the operating railroad. A metal badge plate showing this number and the safe working pressure shall be attached to each boiler.

Rule 5—Specifications of each boiler shall be kept on file in the office of the chief mechanical officer of the railroad. Within ninety days after this rule becomes effective, each railroad will file report (Form MD-25) with the chief mechanical officer of the railroad and a copy with the Assistant Director, Division of Operation, in charge of the Mechanical Department, United States Railroad Administration, Washington, D. C., for each boiler subject to these rules, giving all the data called for thereon.

Rule 6—Each boiler shall have at least one safety valve of sufficient capacity to prevent an accumulation of pressure more than five per cent above the working pressure and shall be connected direct to boiler.

Safety valves shall be set at pressure not to exceed six pounds above the allowed working pressure.

Working safety valve on boiler shall be tested each day boiler is in use. Failure of safety valve to open before an excess pressure of ten pounds has been reached must be immediately reported to the proper authority, and repairs made.

Not less frequently than once each three months all safety valves on boiler shall be tested and adjustment made, if necessary. At this test, as well as at all other tests where the safety valves are adjusted, two steam gages shall be used, one of which shall be in full view of the person adjusting the valves.

Rule 7—Each boiler shall have a steam gage, graduated to at least fifty pounds above the working pressure, connected direct to steam space of boiler, equipped with a suitable siphon and with not more than one cock or valve between boiler and gage. This cock to be located near steam gage.

Steam gages shall be tested at least once each three months, or whenever any irregularity is shown and shall also be tested before any adjustment is made of the safety valves. Each time gage is tested, siphon pipe and cock must be cleaned and examined.

Rule 8—Each boiler shall have at least three gage cocks and one waterglass, so located that the lowest reading shall be at least three inches above the lowest safe water line. Each waterglass shall be equipped with a valve at each end of glass and with a blowoff or drain at bottom of glass. Gage cocks, waterglass and water column valves, cocks and connections shall be maintained in an operative condition free from leaks and shall be cleaned of scale each time boiler is washed.

Suitable lights shall be provided for waterglass and steam gage.

ANNUAL INSPECTION

Rule 9—Before being placed in service and not less than once each twelve months thereafter, each boiler shall be subjected to a hydrostatic pressure 25 per cent greater than the working pressure and the boiler and appurtenances carefully examined while under pressure.

After hydrostatic pressure has been applied, a thorough inspection shall be made of every accessible part of the boiler. Manholes shall be removed to permit of interior inspection.

Boiler having lap joint longitudinal seams should be examined with special care to detect grooving or cracks at edge of seams.

Water tube boilers should be examined with special care to detect blis-

tering on the tubes, tubes bending and leakage or corrosion where tubes are fastened to headers.

Soot and cinders shall be cleaned from furnace and combustion chamber and a thorough inspection made of the brick lining and setting, the fire wall-baffles and grates.

Threaded and flange joints on steam header, steam pipe and blowoff line shall be carefully examined for signs of corrosion or wasting.

After repairs are completed the boiler must be fired up, safety valves set, and boiler and appurtenances examined. All cocks, valves, seams, pipes, flanges and joints must be tight under this pressure.

All defects disclosed by any of the above inspections must be repaired before the boiler is returned to use.

A certified report of the inspection and repairs (Form MD-27) shall be filed with the chief mechanical officer of the railroad and a copy sent to the Assistant Director, Division of Operation, Mechanical Department, Washington, D. C.

Rule 10—Locomotive type boilers working under a pressure of 125 pounds or more shall have the staybolts tested at least once each month. Locomotive type boilers working under a pressure of less than 125 pounds shall have the staybolts tested at least once each three months. Vertical boilers working under a steam pressure of 100 pounds or less shall have the staybolts tested each time the hydrostatic test is applied. No boiler shall remain in service with five or more broken staybolts.

Rule 11—Boilers shall be thoroughly washed as often as water conditions require, but not less frequently than once each month. Special care shall be given to water tube boilers to prevent an accumulation of scale in the tubes and the tubes must be scraped, if necessary. At washout periods, soot, ashes and cinders shall be cleaned from furnace and combustion chamber, and brick lining, setting and fire wall examined.

SEMI-ANNUAL INSPECTION

Rule 12—Not less frequently than once each six months an inspection of the boiler under steam shall be made by a competent inspector. He shall test the safety valves, gage cocks and waterglass, blowoff valve, examine and test the feed pump or injectors, examine steam pipes for leaks, giving close attention to leaks around threaded joints, see that pipes are well braced, that all valves are operative, examine the setting of the boilers and the general condition of the boiler room, with especial reference to fire risks.

He shall report any defects found to the division officer in charge and to the local officer in charge so that prompt repairs can be made.

A certified report of the inspection and repairs (Form MD-26) shall be filed with the chief mechanical officer of the railroad and a copy sent to the Assistant Director, Division of Operation, Mechanical Department, Washington, D. C.

MISCELLANEOUS RULES

Rule 13—Boilers equipped with fusible plugs shall have plug cleaned of scale not less than once each three months.

Rule 14—Boilers in batteries connected to same steam header shall each have a suitable valve between boiler and header, which must be maintained in an operative condition.

Rule 15—Each steam outlet from boiler (except safety valve connections) shall be equipped with a suitable valve, which must be maintained in an operative condition.

Rule 16—Injectors and pumps must be kept in such condition that they will feed water into the boiler against the maximum pressure allowed on the boiler.

Rule 17—Feed water heaters shall be cleaned and inspected as often as water conditions require, but not less than once each three months.

Rule 18—Boilers with any of the following defects shall be withdrawn from service until after proper repairs are made: Cracks in cylindrical boilers or headers; bags or bulges in shells of external fired boilers or unstayed surfaces of internal fired boilers; bulges in arch or water tubes; more than one gage cock inoperative; safety valve inoperative.

Rule 19—Boilers showing indications of having been low in water or of mud burning shall not be used until after inspection by a competent inspector.

Rule 20—Where necessary to plug flues, the plugs shall be tied together with a rod not less than $\frac{1}{4}$ inch in diameter and a report of same made to the officer in charge, who will have proper repairs made.

Rule 21—When making internal inspection of one of a battery of boilers, another employee will be stationed outside of boiler, whose duty shall be to prevent steam valves from other boilers being opened into boiler being inspected.

Rule 22—The boiler room shall be kept in a clean and sanitary condition, old clothes, waste, etc., must not be allowed to accumulate in or around boiler room.

Rule 23—An annual certificate of inspection shall be posted under glass in a conspicuous place in the boiler room. This certificate shall show the number of the boiler, the allowed working pressure, the date of inspection and the signature of the inspector.

Rule 24—Inspection certificates may be made in triplicate and copy filed with state inspector of boilers, when desired.

The above rules shall become effective January 1, 1919, as minimum requirements and shall be put in full force on each railroad under federal control on that date. When a railroad has in effect additional rules which provide greater safeguards such additional rules may be continued in effect.

SHOPS ON EIGHT-HOUR BASIS

Frank McManamy, assistant director of the Division of Operation, has sent to the regional directors the following interpretation of the director general's order to reduce shop hours wherever practical to eight per day, stating that the numerous inquiries received and the different ways in which this has been put in effect clearly indicates it has not been uniformly understood:

"The purpose of this order was to reduce the hours worked

in locomotive shops and roundhouses and in car shops and repair yards to a basis of eight hours per day on December 9. At roundhouses and other places where the work is continuous 24 hours a day three eight-hour shifts should be established. In shops where a single eight-hour shift will not properly maintain the equipment a second shift should be organized as soon as men can be obtained, pending which the work should be taken care of by necessary overtime in accordance with agreements with the employees.

"It is believed that under present conditions of business with increased force, which is available, that at practically all points shop work can be handled on the eight-hour basis without the necessity of requiring excessive overtime, and every effort should be made to do this."

TO RETAIN SKILLED RAILROAD MEN

The mechanical department of the Division of Operation is taking steps to prevent the possible loss of trained shop employees to the railroad service as a result of any reduction in force which may seem necessary at particular points. If the men are not needed at one place arrangements will be made to locate them elsewhere, as it is believed that more men instead of less men will be needed in the next few weeks. Frank McManamy, assistant director of the Division of Operation, has addressed a letter to the regional directors stating that a number of cases have recently been brought to his attention where in the readjustment of shop forces skilled workmen have been laid off.

"Every trained railroad employee represents a certain definite investment," Mr. McManamy said, "therefore, when reorganizations make reductions in forces necessary, all reasonable efforts should be made to retain these men in railroad service. Before a reduction in force is made at any point, steps should be taken to ascertain if the men to be laid off cannot be profitably used at some other point, either on that line or on some other line within your region, in which event transfer should be made and transportation provided.

"If the men cannot be profitably used in your region, this office should be advised, giving the number of skilled workmen to be released and their occupation, so that efforts may be made to place them elsewhere, thus retaining in railroad service, men who have been trained and are proficient in that line of work."

APPRENTICE SYSTEM MAY BE EXTENDED

Frank McManamy, assistant director of the division of operation of the Railroad Administration, has been designated by the administration to confer with the government Board for Vocational Education on plans for the co-operation of the Railroad Administration in the development and extension of the apprentice system for training railway employees. The board has been in existence for about a year, having been appointed for the purpose of investigating and recommending methods of vocational education. Mr. McManamy, held his first conference with the board early in December.

WAGE INTERPRETATION

Interpretation No. 2, to Supplement No. 7 to General Order No. 27:

Question:—Shall employees coming under the provisions of paragraph (a) Article V, Supplement No. 7 to General Order No. 27, paid on a tonnage or piece-work basis and earning in excess of 43 cents per hour (the maximum rate established) receive any portion of the increase provided for, if thereby such increase would establish a rate in excess of 43 cents per hour.

Decision:—Paragraph (2) Article V of Supplement No. 7 to General Order No. 27 specifically states, "Provided that the maximum shall not exceed 43 cents per hour." Employees paid on a tonnage or piece-work basis whose average hourly earnings, per day period, equal 43 or more cents per

hour are therefore not entitled to any portion of the increase, but are guaranteed not less than 43 cents per hour.

The provisions of paragraph (2) Article VIII, Supplement No. 7 to General Order No. 27, protects higher rates and is to be observed.

MATERIAL STANDARDS FOR FREIGHT CAR REPAIRS

Frank McManamy, assistant director of the Division of Operation, has issued Mechanical Department Circular No. 8, prescribing material standards for freight car repairs as follows:

When renewing parts or applying betterments to freight cars owned by the railroads under federal control, if suitable material, either new or second hand, that is standard to the car, is in stock it shall be used. Where such material is not in stock, material standard to United States standard cars should be used if available.

1. *Bolsters*—Body bolsters, when renewals are made, should be either cast steel or built-up type.

Truck Bolsters—When renewals are made should be cast steel box girder type.

2. *Column Castings*—Truck column castings when used should be made of malleable iron or cast steel.

3. *Side Bearings*—If body or truck side bearings require changing or renewing, frictionless type should be used, interchangeable in capacity and dimensions with those used on United States standard cars.

4. *Side Truck Frames*—When necessary to renew side truck frames, cast steel U-shaped section, United States standard car type with separable journal boxes to be used.

5. *Coupler Operating Device*—Coupler operating device to be of type directly connected to coupler knuckle lock without use of clevis, link, chain or pin and to be interchangeable with operating device on United States standard cars where possible.

6. *Draft Gears*—(a) Friction draft gears, either Cardwell, Miner, Murray, Sessions Type "K," Westinghouse or similar gears, of not less than 150,000 lb. capacity with a maximum travel of $2\frac{3}{4}$ in.

(b) Spring draft gears, if used, to be at least equal in capacity to two M. C. B. Class "G" springs, interchangeable with friction gear without change in car construction.

(c) Clearance between coupler horn and striking casting to be three inches.

(d) Coupler to be key connected to draft gear.

7. *Hand Brakes*—If renewals are required on open top cars, hand brakes should be changed to drop handle type and so located as to be below top of car where construction of car will permit and of a type interchangeable with United States standard cars.

8. *Doors*—Side doors on box or stock cars (except double-deck stock cars) will be bottom supported, the attachments uniform with those on United States standard cars.

9. *Ends*—Box cars with weak constructed ends requiring two-thirds of end to be renewed, should be reconstructed as follows:

(a) Horizontal corrugated steel ends (two or three piece) having top section $\frac{3}{16}$ in. thick and bottom section or sections $\frac{3}{4}$ in. thick and corrugations $2\frac{1}{4}$ in. deep.

(b) Vertical reinforced ends with four or five-inch Z-bars, securely fastened to place on end sills and end plates. End plates to be diagonally braced on inside of car, under roof, to side plates, or with reinforcements equivalent in strength.

(c) End lining to be $1\frac{3}{4}$ in. thick, tongued and grooved, extending from floor to end plate, with corners sealed with beveled corner strips $1\frac{1}{2}$ by $1\frac{1}{2}$ in., securely nailed to place to prevent possibility of grain leaks.

10. *Metal Strap to be Applied to Side Sheathing*—Double sheathed box cars will have applied to face of sheathing of car at side sill a small angle iron, channel iron or strap se-

curely bolted in place to insure sheathing being held tight against side sill to prevent grain leakage; bolts to have single nuts and to be riveted over. Location of bolt spacing to be the same as on United States standard cars where practicable. Channel or strap to be painted on back with freight car paint before it is applied.

11. *Grain Door Nailing Strip*—Door post should have grain door nailing strips on inside face (approximately $1\frac{1}{2}$ in. by $3\frac{1}{2}$ in.), full height of door opening securely fastened to place with screws or heavy wire nails.

12. *Roofs*—When roofs are changed or renewed outside flexible type metal roof with mullions between roof sheets and with flexibility at eaves and ridges, made of 22 or 24 gage galvanized iron will be applied. Roofs should be interchangeable with United States standard cars having same length and width sheets. To permit the use of standard sheets, the following changes may be made:

(a) Increase or decrease in thickness, or omitting eave molding, fascia or both.

(b) Increase the width of roof flashing at eaves.

(c) Where cars are equipped with all-metal roofs, such construction may be continued when renewals are necessary, if considered desirable to do so.

13. *Preservation of Material*—When rebuilding or repairing wood or steel cars—On all-wood cars, wood preservative, freight car paint or its equivalent will be applied to all mortises and tenons; ends of posts and braces; and post and brace shoes at sills. Top of all sills will be painted, including face of side and end sills.

(a) On refrigerator cars, sills will be painted all over in addition to the above.

(b) When applying metal parts on outside of wood cars, both the wood and metal part shall be painted before applied, except when applying metal roofs. Before outside metal roof is applied it should be painted on underside.

(c) Steel cars, steel underframes, steel center sills or steel draft arms, when assembling should have red lead applied to the surfaces before one metal part is applied, lapsing another.

In complying with the above instructions, it is imperative that careful consideration be given to preservation and replacement of material. Material removed from one car, in order to standardize such car or a part thereof, fit for further use, shall be reclaimed and used in making repairs to other equipment.

REPAIRS TO FREIGHT CARS

The Division of Operation has issued a revision of Circular No. 20, regarding the limit of cost for repairs to freight cars in which rule No. 7 is changed to read as follows:

"When the cost of repairs in kind exceeds the amount which may be expended and betterments are not to be applied, repairs will not be made. The federal manager, or general manager on roads having no federal manager, will endeavor to secure an agreement with the owning corporation that such cars may be dismantled upon the basis of settlement established in the current Master Car Builders' Association rules. When such agreements have been secured he may authorize in writing that the car will be dismantled. If such an agreement has not been secured the car will not be dismantled, but will be held for disposition and the regional director advised."

DESIGNS FOR PASSENGER CARS

The Committee on Standards of the mechanical department of the Railroad Administration at a meeting in Washington last week agreed upon the floor plan and general designs of the proposed standard 70-ft. passenger coach and the 70-ft. combination passenger, baggage, mail and express cars. The general designs and the specialties selected follow very closely those approved for the proposed standard baggage cars.

ORDERS OF REGIONAL DIRECTORS

Rental Charge for Locomotives.—In Order 126 the Southwestern regional director announces that the rate for the rental of locomotives to industries and small lines has been set at one-tenth cent per pound of tractive power per day, with a minimum of \$30 per day. This rate of rental will apply in all cases where locomotives are loaned to any such industries or small lines.

Working Hours in Shops.—In Supplement 1 to Order 141 the Southwestern regional director issued instructions regarding the period to be allowed for meals in roundhouses and other places where three eight-hour shifts are worked. Most of the agreements which are in effect provide for a lunch period of not to exceed 20 minutes, with pay, for men who are working one of the eight-hour shifts. Men who are employed in shops or roundhouses or other places where less than three shifts are worked generally have a meal period of not to exceed one hour without pay. These practices, pending further action by the Railroad Administration, will govern except when more favorable conditions are provided by the agreements in effect.

M. C. B. Brake Shoe Keys.—The Eastern regional director, file 500-70A348, advises that the executive committee of the Master Car Builders' Association calls attention to the fact that a great number of brake shoe keys are being made which do not conform to the Master Car Builders' standard, and which are made, in many cases, of inferior material. The substitute brake shoe keys are of numerous types, with the result that they work down from the lugs of the brake

head and shoe, resulting in loss of the shoe and key. Brake shoes should not be applied unless the key is provided with a head, and of sufficient strength for the service, as is shown on Master Car Builders' Sheet No. 17, Volume 51, of the Master Car Builders' Association proceedings.

Placing of Common and Semi-Skilled Labor on an Eight-Hour Basis.—The Eastern regional director, file 1200-4-56A352, states that it has been brought to his attention that in applying Interpretations No. 1 to Supplements Nos. 7 and 8 to General Order No. 27 very substantial increases will be given to the various classes of common labor where heretofore paid on an hourly or daily basis. The indications are that labor conditions will be very much improved within the next week or two, and it appears that this would be an opportune time to place all maintenance of way, common and semi-skilled labor, also other classes of common labor, on an eight-hour basis.

Removal of Coal and Water from Engines.—The Eastern regional director, file No. 500-1-68A336, orders that when engines are moved dead to repair shops it is desired that coal and water be removed before shipment is made.

Violations of Safety Appliance Laws.—In Order 144 the Southwestern regional director states that numerous violations of safety appliance laws and of the director general's order No. 8 are being reported by traveling federal inspectors. He directs that immediate action be taken effectively to stop these violations; car and mechanical department heads should be given to understand that the federal laws and the orders of the director general must be observed.

CAR AND LOCOMOTIVE ORDERS IN 1918

The Railroad Administration and the Director General of Military Railways Are the Principal Buyers

THE number of locomotives reported as having been ordered during the 12 months of 1918, according to figures compiled by the Railway Age, was 4,888, of which 2,802 were on domestic orders for companies in the United States and Canada, and 2,086 were on orders for shipments to other countries. These figures compare with a total in 1917 of 6,142, of which 2,704 were on domestic orders and 3,438 were for export, principally to the war zone in France.

The leading feature in the locomotive market during the past year, as in every other essential industry in the country, was the predominance of government orders. Of the 2,593 locomotives reported as having been ordered for service in

Of the total of 2,086 locomotives ordered for export, no less than 1,404 were on orders for the United States military railroads, this figure excluding those orders that were cancelled after the signing of the armistice. The remainder of the orders for export also included a considerable number of locomotives for foreign governments—South Africa, England, Chili, China, Italy, etc.

The number of locomotives ordered for domestic service

TABLE I—THE LOCOMOTIVE ORDERS IN 1918

Domestic—	
United States Railroad Administration.....	2,030
Other railroad orders.....	525
Industrials, etc.	38
Total United States.....	2,593
Canadian railroads	209
Total domestic	2,802
Foreign—	
Director General Military Railroads.....	1,404
Other foreign	682
Total foreign	2,086
Total of all orders.....	4,888

the United States (excluding the domestic orders for Canada), no less than 2,030 were included in the orders for standard locomotives placed by the United States Railroad Administration. Of the 209 locomotives ordered for roads in Canada 195, or practically all, were ordered by the Canadian government for the Canadian Government Railways.

TABLE II—DOMESTIC ORDERS FOR LOCOMOTIVES SINCE 1901

Year	Locomotives	Year	Locomotives
1901.....	4,340	1910.....	3,787
1902.....	4,665	1911.....	2,850
1903.....	3,283	1912.....	4,515
1904.....	2,538	1913.....	3,467
1905.....	6,265	1914.....	1,265
1906.....	5,642	1915.....	1,612
1907.....	3,482	1916.....	2,910
1908.....	1,182	1917.....	2,704
1909.....	3,350	1918.....	2,802

in 1918, inclusive of the Canadian orders, as will be seen from Table II, was greater than last year but not as great as 1916. It was greater than the totals of domestic orders in 1914 and 1915, which were poor years. It was only about 1,700 less than in 1912 and bears no comparison whatever to the big totals of 1905 and 1906. The orders for export were likewise not as great as in 1917. They bade fair to be much the same as those of that year, but the signing of the armistice put an end to the placing of further orders for the United States military railroads and resulted in cancellations of orders already placed, amounting to 1,500, in the latter part of November.

Table III gives a resumé of the standard locomotives delivered to December 21, 1918. It will be noted from this

table that the American Locomotive Company produced by far the larger proportion of the 678 that had been completed to date. The Baldwin Locomotive Works, which produced only 112, was engaged for several months almost entirely

years of 1906 and 1907, when 6,952 and 7,362 locomotives were produced respectively.

FREIGHT CARS ORDERED IN 1918

Because of the 100,000 standard freight cars ordered by the United States Railroad Administration in 1918, of which, however, only about 12 per cent had been delivered to the end of December, the orders for freight cars in 1918 for domestic service in the United States and Canada were considerably in excess of those of 1917. They were not, however, as great as those of 1916, were only half those of 1912,

TABLE III—STANDARD LOCOMOTIVES DELIVERED TO DEC. 21

Alabama & W. Point & Western Ry. of Ala.	2	0-8-0....American
Atlantic Coast Line.....	5	0-6-0....American
Baltimore & Ohio.....	50	Light 2-8-2....Baldwin
Central of New Jersey.....	10	0-6-0....American
Chicago & Alton.....	10	Heavy 2-8-2....American
Chicago Junction.....	14	Light 2-8-2....American
Chicago & Eastern Illinois.....	15	0-6-0....American
Chicago Great Western.....	10	Light 2-8-2....American
Chicago, Milwaukee & St. Paul.....	50	Heavy 2-8-2....Baldwin
Cleveland, Cincinnati, Chicago & St. Louis.	25	Light 2-8-2....American
El Paso & Southwestern.....	5	Heavy 2-8-2....Baldwin
Erie.....	16	0-8-0....American
Grand Trunk Western.....	15	Heavy 2-8-2....American
Grand Trunk—East.....	15	Light 2-8-2....American
Lake Erie & Western.....	15	Light 2-8-2....American
Lehigh & Hudson River.....	4	Light 2-8-2....Baldwin
Louisville & Nashville.....	20	Heavy 2-8-2....American
Michigan Central.....	20	Light 2-8-2....American
Nashville, Chattanooga & St. Louis.....	10	Light 2-8-2....American
New York Central.....	33	Light 2-8-2....Lima
New York, Chicago & St. Louis.....	25	0-8-0....American
Pennsylvania Lines West.....	17	Light 2-8-2....American
Pittsburgh & West Virginia.....	3	Light 0-6-0....American
Pittsburgh, McKeesport & Youghiogheny.....	10	Light 2-8-2....Baldwin
Rutland.....	2	Heavy 2-8-2....American
Seaboard Air Line.....	6	Light 0-8-0....American
Southern.....	10	Light 2-8-2....American
Terminal R. R. of St. Louis.....	25	0-8-0....American
Texas & Pacific.....	29	Light 2-10-2....American
Toledo & Ohio Central.....	6	0-6-0....American
Union Pacific.....	11	Light 2-8-2....American
Wabash.....	5	0-8-0....American
Western Pacific.....	15	Light 2-8-2....American
Wheeling & Lake Erie.....	20	Light 2-8-2....American
	5	Light 2-8-2....Baldwin
	10	Heavy 0-8-0....American
		Heavy 2-8-2....American
Total—Six-wheel switching, American.....	56	
Eight-wheel switching, American.....	75	
Light Mikado, American.....	253	
Baldwin.....	112	
Lima.....	33	
Heavy Mikado, American.....	398	
Light Santa Fe, American.....	120	
	29	
Total to December 21.....	678	

on locomotives for the United States Military Railroads overseas.

LOCOMOTIVE PRODUCTION IN 1918

The total number of locomotives produced in 1918 was 6,475, including 3,668 on domestic orders and 2,807 on orders for the United States military railroads and for other railroads outside the United States and Canada. This total

TABLE IV—THE LOCOMOTIVES BUILT

Domestic.....	3,668
Foreign.....	2,807
Total.....	6,475

Comparison with Previous Years					
Year	Domestic	Foreign	Total	Year	Domestic Foreign Total
1896.....	866	309	1,175	1907*	6,564 798 7,362
1897.....	865	386	1,251	1908*	1,886 456 2,342
1898.....	1,321	554	1,875	1909*	2,596 291 2,887
1899.....	1,951	514	2,475	1910*	4,441 314 4,755
1900.....	2,648	505	3,153	1911*	3,143 387 3,530
1901.....	.....	.....	3,384	1912†	4,403 512 4,915
1902.....	.....	.....	4,070	1913†	4,561 771 5,332
1903.....	.....	.....	5,152	1914†	1,962 273 2,235
1904.....	.....	.....	3,441	1915†	1,250 835 2,085
1905*	4,896	595	5,491	1916†	2,708 1,367 4,075
1906*	6,232	720	6,952	1917†	2,585 2,861 5,446
				1918†	3,668 2,807 6,475

* Includes Canadian output.

† Includes Canadian output and equipment built in railroad shops.

compares with a total of 5,446 in 1917, of which 2,585 were for domestic service and 2,861 for export. In spite of the high rate of production which was attained at various times during the year the total was not as great as in the peak

TABLE V—THE FREIGHT CAR ORDERS IN 1918

Domestic—	
United States Administration.....	100,000
United States Army or Navy.....	740
Other railroad orders.....	1,227
Private car lines and industrials.....	12,146
Total United States.....	114,113
Canadian railroads.....	9,657
Total domestic.....	123,770
Foreign—	
Director General Military Railroads.....	36,875
Other foreign.....	16,672
Total foreign.....	53,547
Total of all orders.....	177,317

and did not compare at all with those of the big years 1905 and 1906.

The orders for freight cars in 1918 totaled 177,317, of which 123,770 were on domestic orders and 53,547 were on foreign orders, principally for the United States Military Railroads in France. The orders in 1917 totaled 131,558 (excluding the 30,500 Russian cars which were cancelled), of which 79,367 cars were for domestic service and 34,167 were for export, principally for France and the Military Railroads.

The passenger car orders for 1918 were practically non-existent, war-time activities and presumably the omnipresent government desire for standardization not permitting the placing of such orders. The orders for passenger cars

TABLE VI—THE PASSENGER CAR ORDERS OF 1918

Domestic, United States and Canada.....	131
Foreign.....	26
Total.....	157

totaled only 157, including 131 for domestic service and 26 for export, as compared with 1,167 in 1917, of which 1,124 were for domestic service, 6 for the United States Government and 37 for export.

As in the case of locomotives, the predominating feature during the past year, insofar as the orders for freight cars were concerned, was the great proportion the government purchases held to the total orders. Unlike 1917, there were few orders from governments of other countries. The gov-

TABLE VII—DOMESTIC ORDERS FOR CARS SINCE 1901

		Freight cars	Passenger cars			Freight cars	Passenger cars
1901.....	193,439	2,879	1910.....	141,024	3,881		
1902.....	195,248	3,459	1911.....	133,117	2,623		
1903.....	108,936	2,310	1912.....	234,758	3,642		
1904.....	136,561	2,213	1913.....	146,732	3,179		
1905.....	341,315	3,289	1914.....	80,264	2,002		
1906.....	310,315	3,402	1915.....	109,792	3,101		
1907.....	151,711	1,791	1916.....	170,054	2,544		
1908.....	62,669	1,319	1917.....	79,367	1,167		
1909.....	189,360	4,514	1918.....	123,770	131		

ernment orders referred to were those placed by our own authorities, either the United States Railroad Administration or the Director General Military Railroads.

The year opened very auspiciously with prospects for heavy orders from the railroads, which were soon dispelled with the announcement that purchases for our own railroads would be centralized and placed by the Railroad Adminis-

These military cars have been an important factor in the year's business, but they have not been sufficient to impede the production of other cars, and it cannot be said that the car building plants have been particularly rushed at any time.

The resumé of freight car orders on hand on November 1 shows a total of 235,614 cars, of which only 20,400 had been delivered, leaving a total of 215,214 still to be delivered, divided about evenly between foreign and domestic orders. This total represents nearly double as many cars as have on the average been produced annually for the past five years inclusive of 1918. Even with the elimination of such orders for the United States Military Railroads as have been cancelled since November 1, the indications for a big year from the production standpoint in 1919 are very favorable.

The largest single order remaining is, of course, that of 100,000 cars for the United States Railroad Administration. As of November 1, only 2,742 of these cars had been deliv-

ered, a figure which had been brought up on December 21 to 11,815. The table headed Standard Car Deliveries to December 21, 1918, will show to what railroads these cars have gone.

FREIGHT CAR PRODUCTION IN 1918

The number of freight cars built in 1918, as shown in one of the tables, totaled 124,708, of which 81,767 were on domestic orders and 42,941 for the United States Military Railroads, or for other foreign service. The total production for 1918 was less than in 1917, when 151,401 cars were produced, of which 119,363 were for domestic and 32,038 were for foreign service. From the standpoint of domestic production, 1918 was one of the low years in the period from 1899 to date, but the production of cars for foreign service was by far the largest yet reported.

The production of passenger cars in 1918 was very low, the total of 1,573 being the lowest since 1901.

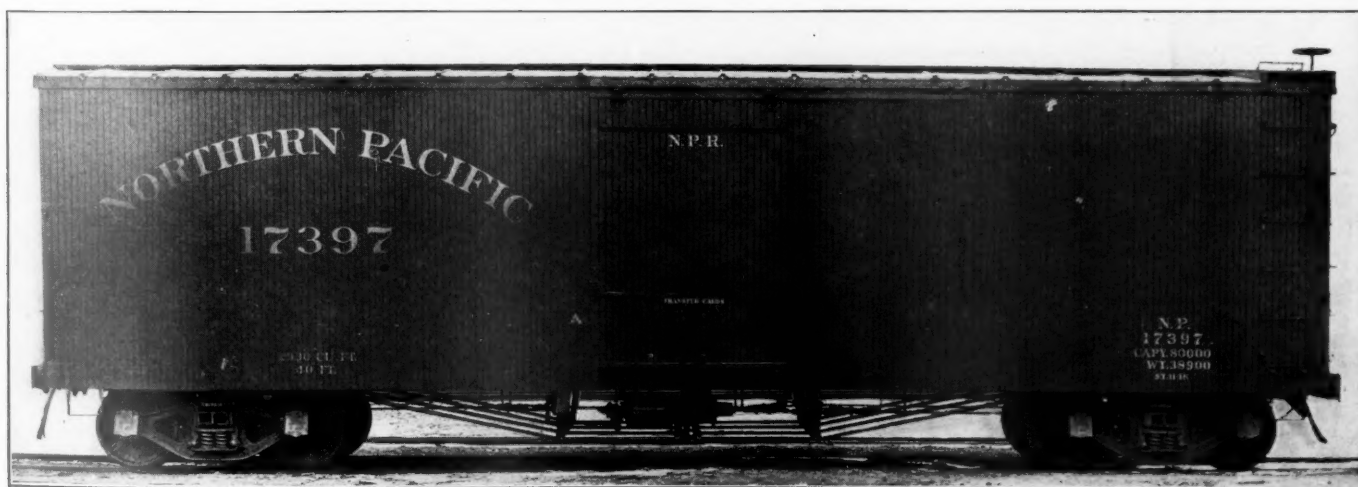
NORTHERN PACIFIC BUILDS BOX CARS

Interesting Design of Underframe and End on Cars Now Being Constructed in Company Shops

THE necessity for saving steel in freight cars in every way possible, on account of the large numbers constructed, was quite generally realized during the war. The abnormal shortage in the supply of bars and plates resulted in many interesting designs of rolling stock being brought out. The extent to which wood can well be used varies, of course, with the type of car. The problem under war conditions was to keep down the amount of steel and at the same time provide a car that would not require much labor for upkeep. Man power was as essential as steel in the great conflict. For that reason it was not advisable to

carried on as the regular work permits. The use of steel in these cars is confined almost entirely to the center sills and end posts. The cars are 41 ft. $\frac{3}{4}$ in. long over the end sills, 13 ft. $5\frac{1}{2}$ in. from the rail to the top of the running board and 9 ft. $5\frac{3}{8}$ in. wide over the eaves. They have a capacity of 2,990 cu. ft. and weigh 38,600 lb.

The underframe consists of a combination of a steel center sill with wooden side and intermediate sills and truss rods. The center sill is built up of two 10-in. 20-lb. channels, extending continuously the entire length of the car, with top and bottom cover plates. At each end of the channels



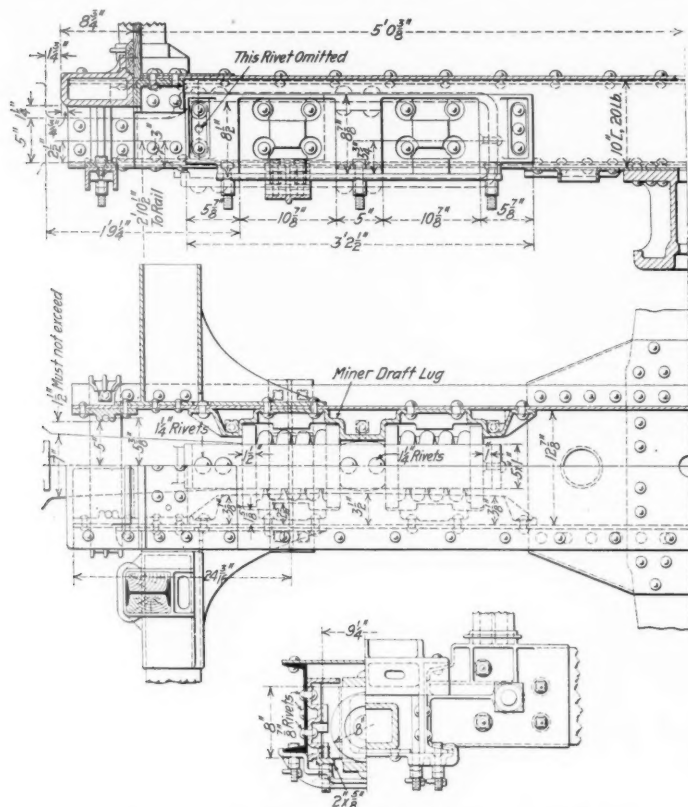
Northern Pacific Box Car of Wood Construction With Steel Center Sills and End Posts.

save a small amount of steel in building a car that would waste labor as long as it was kept in service.

A good example of a car in which wooden construction is supplemented by the use of a moderate amount of steel in the parts where it is required to enable the equipment to withstand the present severe service conditions, is found in an order of 1,000 box cars of 80,000 lb. capacity now being built by the Northern Pacific. These cars are being constructed at eight different shops on the system where the necessary facilities are available and the building is being

there is a $\frac{1}{4}$ -in. by $18\frac{3}{8}$ -in. top cover plate 11ft. $\frac{3}{8}$ in. long and above the needle beams there are tie plates $\frac{1}{4}$ in. by $18\frac{3}{8}$ in. by 18 in. On the under side the channels are reinforced for the entire distance between the rear draft lugs. At the center there is a $\frac{1}{4}$ -in. by $18\frac{3}{8}$ -in. bottom cover plate 25 ft. 6 in. long, while at each end there is a diamond shaped bolster and center sill gusset plate with flanged edges which furnishes diagonal bracing for the body bolster. The draft lugs are of malleable iron of the Miner double pocket type arranged to house two M. C. B. class G springs. The center

line of draft is three inches from the bottom of the center sill channels. Sharon couplers with 5-in. by 7-in. shanks are used. The buffer castings are of cast steel riveted be-



Details of Center Sill End and Draft Rigging

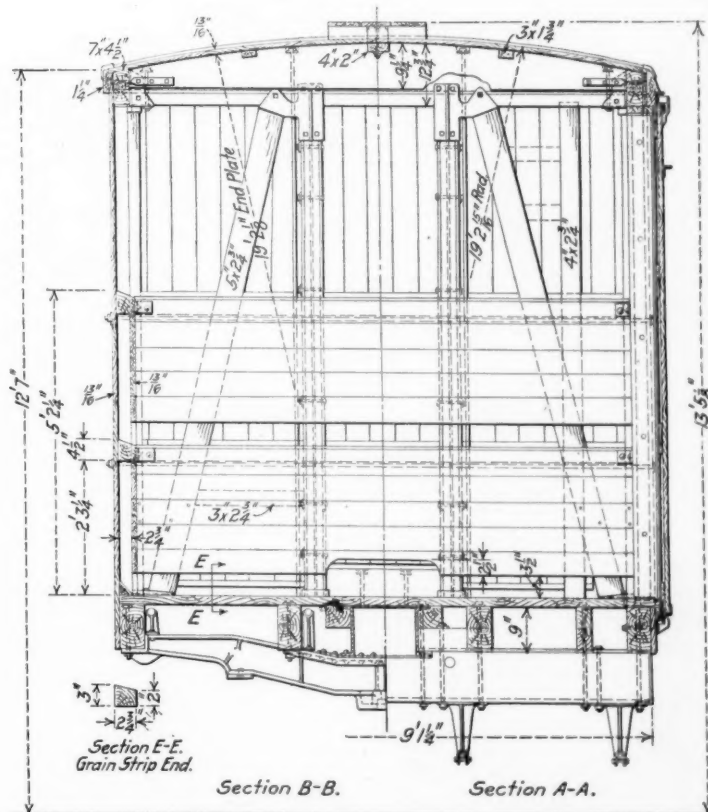
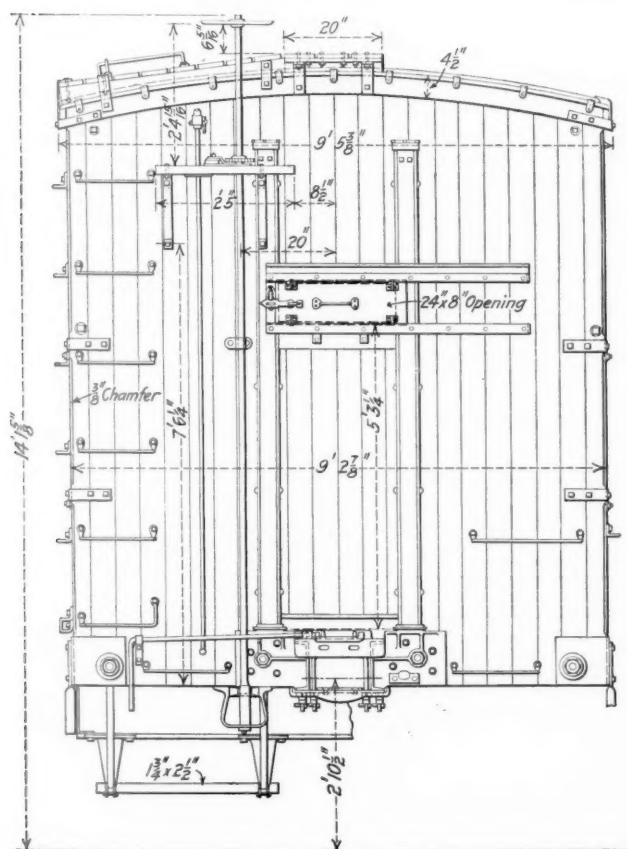
tween the center sill channels and reinforced by a forged angle riveted to the cover plate and sills. The buffer castings and

carrier irons are designed to permit the future application of a coupler with a 6-in. by 8-in. shank if desired. In order to bring the 5-in. by 7-in. shank coupler to the proper height a 1/2-in. filler plate is riveted to the top of the malleable carrier iron. By replacing these plates when worn the standard coupler height can readily be maintained.

As the side sills are not elevated above the level of the center sills, a continuous end sill cannot be used. The two parts of the end sills, which are of a 6 in. by 10¾ in. section, are fitted into malleable iron castings riveted to the outside of the center sill channels, as shown in the detail drawing of the draft rigging. The two center end posts fit into pockets in these castings. The end sills have pockets bolted to them into which the four 5-in. by 9-in. longitudinal sills are fitted. The sills are supported by the cast steel body bolster, which extends under the center sill, and by two needle beams spaced 8 ft. apart. Just inside of each sill there is a 1½-in. truss rod with 1¾-in. upset ends. In order to strengthen the floor at the door openings, two 3-in. by 9-in. sills, extending 3 in. beyond the needle beams, have been located 7⅛ in. from the side sills. The sills, and all other wooden parts of the car as well, are of fir.

The end framing of the car consists of 4 3/8-in. by 5-in. wooden corner posts and two intermediate posts made up of a 5-in. I-beam with wooden fillers on each side. These posts fit into pockets in the castings on the center sills, as already mentioned, and are galled on each side to receive the siding. The upper ends of the posts are set into castings bolted to the end plates into which the 2 3/4-in. by 5 1/2-in. diagonal braces are also fitted. At one end of the car there is a sliding door 8 in. high and 24 in. wide, 5 ft. 3 1/4 in. from the floor. The end and side doors have Camel fixtures.

The side framing is made up of 2 3/4-in. by 5 1/2-in. posts and braces. The door posts are 5 1/2 in. by 5 3/8 in. and are reinforced with a 5-in. by 3/8-in. plate flanged against the underside of the side plates and flooring. All the body rods are 5/8 in. in diameter with ends upset to 3/4 in. The siding



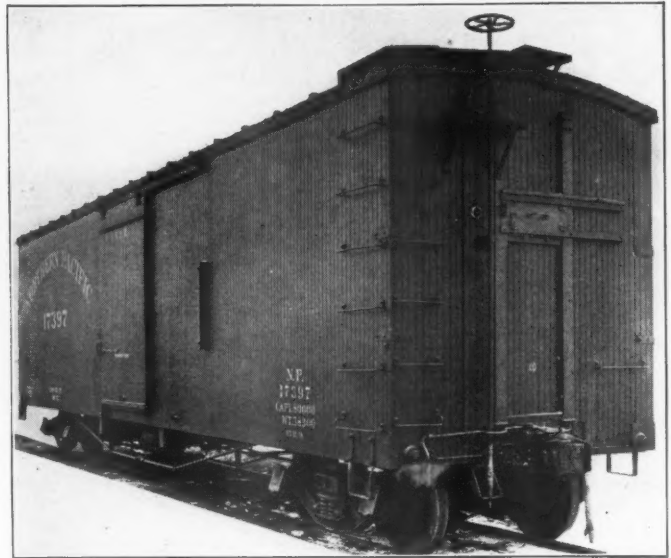
End Elevation and Sections of Northern Pacific Box Cars

and the lining are $13/16$ in. thick tongued and grooved with the exception of the end lining where $1\frac{3}{4}$ -in. material has been used. There are two belt rails spaced 2 ft. $3\frac{1}{4}$ in. and 4 ft. $9\frac{3}{4}$ in. above the floor of a $4\frac{1}{2}$ -in. by $2\frac{3}{4}$ in. section beveled to $3\frac{1}{2}$ in. by $2\frac{3}{4}$ in. The flooring is $1\frac{3}{4}$ in. thick, tongued and grooved. Two nailing strips bolted under the top flanges of the center sills, are provided to furnish support for the floor in addition to that given by the sills. The end sill construction makes it necessary to provide special means for insuring that the ends of the car will be grain tight. This is accomplished at the sides by gaining the end sills to receive the flooring. Between the center posts the flooring is laid on the cover plates and the siding is laid up along the edge of the floor. A high grain strip with a flashing of 24 gage galvanized steel under it is bolted into the corner and a filler is nailed between the siding and the rib on the buffer casting, as shown in section C-C.

The roof is supported on wooden carlines $1\frac{3}{4}$ in. wide and $9\frac{1}{4}$ in. high at the center, tenoned into the side plates. The roof is curved with a radius of 19 ft. 3 in. The roof boards are $13/16$ in. tongued and grooved, laid diagonally and continuous from side plate to side plate. An outside metal roof built to Northern Pacific specifications is applied over them.

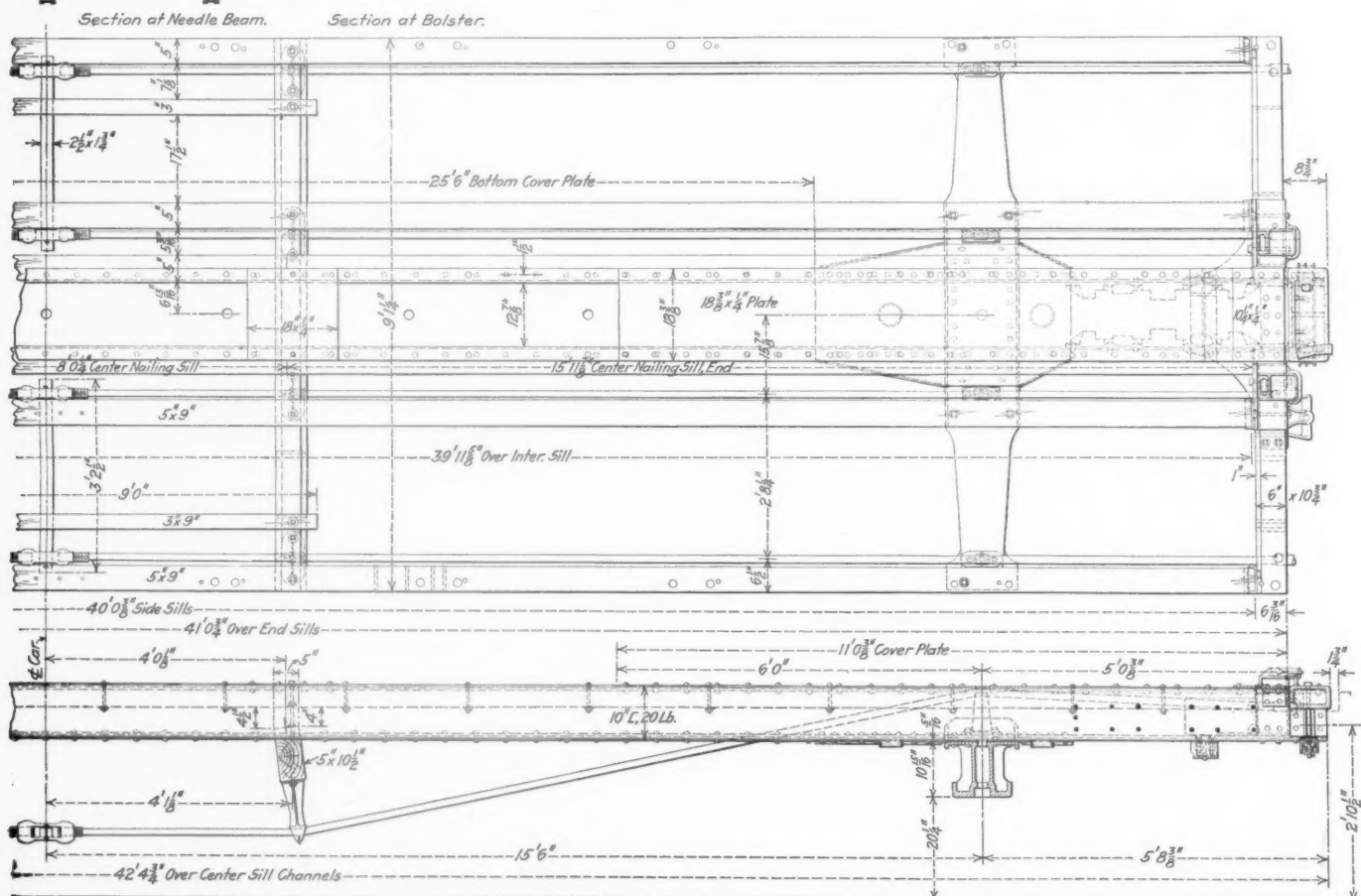
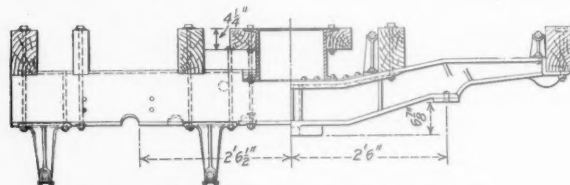
The brake equipment is the Westinghouse Air Brake Company's schedule KC-1012. In connecting the hand brake, the hand brake rod is fastened to one end of an increaser lever, which is fulcrumed at the other end and from an intermediate point is connected to the end of the cylinder

push rod by a chain, giving a power ratio of five to two. Trucks of the Bettendorf type with chilled iron



End View of Northern Pacific Box Car

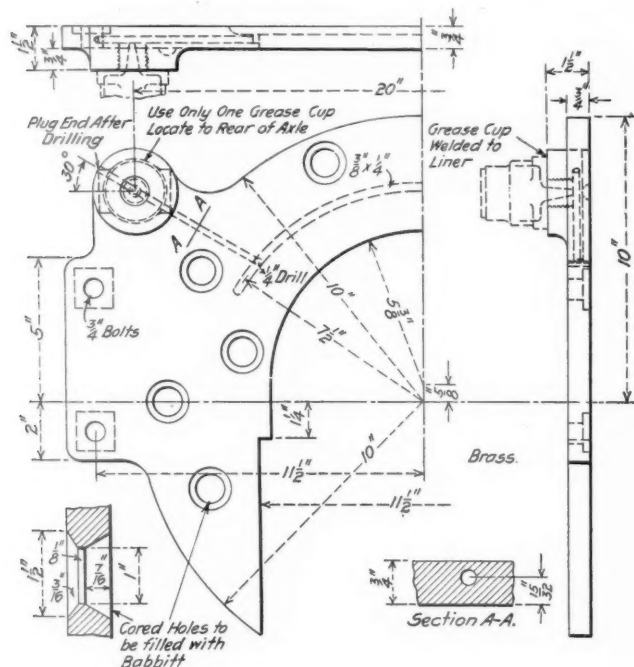
wheels are used under these cars. They are fitted with Barber lateral rollers and Stucki type C side bearing. No. 2 brake beams are used and an angle iron safety holder is bolted under the spring plank.



the same angle as the back-head of the boiler and is set so that it projects forward only a few inches beyond the back-head. With this arrangement all the staybolts in the wrapper sheet are readily accessible for inspection or repairs. The angle of vision through the front cab window is also increased. The front part of the cab, which is eliminated in this design, serves no useful purpose but offers an opportunity for dirt to collect.

The main valves are of the piston type, 14 in. in diameter, and are operated by the Baker valve gear controlled by the Mellin power reverse. The valve chamber and cylinder bushings and piston and valve packing rings are of Hunt-Spiller gun iron. The piston rod packing is of the King type. The Nathan Manufacturing Company's drifting valve is used. A McCord force feed lubricator supplies oil to the valves and the lubrication of the air pump and stoker is provided for by the use of a Nathan two-pint two-feed hydrostatic lubricator.

A departure from the usual practice is the application of grease lubrication to the crossheads and trailer box hub-liners, both of which are illustrated below. The crosshead gibs are of gun iron with recesses in the wearing surfaces filled with babbitt. Grease is fed from a well at the center through a single hole to a groove extending across the face



Trailer Box Hub Liner.

of the gib. The hub-liner on the trailer box is fitted with two lugs to one of which is welded a grease cup. The cup feeds grease to the hub-face at a point behind the center line. An annular groove is provided to facilitate the passage of the lubricant.

The ashpan extends out several inches beyond the sides of the firebox and is flanged upward to the level of the mud-ring. This gives a large air opening and at the same time keeps live coals from falling out or being blown out at the sides of the pan. Electric welding has been used to some extent in the construction of the boiler. The door hole is welded, the sheets being flanged inward and welded together. The firebox sheets are also welded to the mudring at the corners.

The tender used with these locomotives has a flanged bottom and is similar to the design recently described in these columns.* It is carried on a cast steel frame. The air

connections between the locomotive and the tender are made with Barco flexible metallic joints of the 3V type.

Among the specialties not already mentioned applied to these locomotives are Westinghouse ET No. 6 brakes with an 8½-in. cross-compound compressor, Commonwealth locomotive cradle castings, Miner A-18 draft gear, Chambers throttle valves, Pyle-National headlights, Economy radial buffers, Nathan non-lifting injectors, Sellers coal sprinklers, Ashton safety valves and Viloco H double type sander.

The principal dimensions, weights and ratios are given below:

General Data

Gage	4 ft. 8½ in.
Service	Freight
Fuel	Bituminous coal
Tractive effort	71,900 lb.
Weight in working order	383,000 lb.
Weight on drivers	302,500 lb.
Weight on leading truck	26,000 lb.
Weight on trailing truck	54,500 lb.
Weight of engine and tender in working order	572,900 lb.
Wheel base, driving	22 ft. 6 in.
Wheel base, total	41 ft. 3 in.
Wheel base, engine and tender	80 ft. 2¾ in.

Ratios

Weight on drivers ÷ tractive effort	4.21
Total weight ÷ tractive effort	5.33
Tractive effort × diam. drivers ÷ equivalent heating surface*	710.1
Equivalent heating surface* ÷ grate area	79.5
Firebox heating surface ÷ equivalent heating surface, per cent.	6.13
Weight on drivers ÷ equivalent heating surface*	47.4
Total weight ÷ equivalent heating surface*	60.05
Volume both cylinders	26.18 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	243.6
Grate area ÷ vol. cylinders	3.06

Cylinders

Kind	Simple
Diameter and stroke	30 in. by 32 in.

Valves

Kind	Piston
Diameter	14 in.
Greatest travel	.634 in.
Outside lap	1 1/16 in.
Inside clearance	.0 in.
Lead in full gear	3/16 in.

Wheels

Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	12 in. by 20 in.
Driving journals, others, diameter and length	Front 10 in. by 19 in., others 10 in. by 13 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6½ in. by 12 in.
Trailing truck wheels, diameter	43 in.
Trailing truck, journals	9 in. by 14 in.

Boiler

Style	Conical
Working pressure	185 lb. per sq. in.
Outside diameter of first ring	85½ in.
Firebox, length and width	120 in. by 96½ in.
Firebox plates, thickness	Crown, back and sides, ¾ in., tube 5/8 in.
Firebox, water space	Back and sides 5 in., front 5½ in.
Tubes, number and outside diameter	226, 2½ in.
Flues, number and outside diameter	46, 5½ in.
Tubes and flues, length	21 ft. 3 in.
Heating surface, tubes and flues	4,217 sq. ft.
Heating surface, firebox†	391 sq. ft.
Heating surface, total	4,608 sq. ft.
Superheater heating surface	1,180 sq. ft.
Equivalent heating surface*	6,378 sq. ft.
Grate area	80.2 sq. ft.
Center of boiler above rail	10 ft. 2 in.

Tender

Tank	Water bottom
Frame	Cast steel
Weight	189,900 lb.
Wheels, diameter	33 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	10,000 gal.
Coal capacity	16 tons

* Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

† Includes combustion chamber and arch tube heating surfaces.

A MINIATURE MOTOR.—An electric motor of extremely small dimensions has appeared on the market in Germany. The motor is enclosed in a shell of 3 cm. diameter and 4 cm. length and weighs 150g. The shaft is arranged so as to hold tools that are required by dentists and surgeons, but the device should be of great use for other purposes, such as boring small holes in metals and rare stones. The motor can be driven by direct or alternating current, and runs at a maximum speed of 5,000 r.p.m.—*The Engineer, London.*

*See *Railway Mechanical Engineer*, December, 1917, page 673.

LOCOMOTIVE FEED WATER HEATING*

Discussion of the Exhaust Steam and Waste Gas Methods of Preheating for Locomotive Boilers

BY H. S. VINCENT

II.

IN a feed water heater using waste gases as the heating medium, due to the relatively slow absorption of the heat, it is necessary to greatly increase the heating surface over that required for an exhaust steam heater. This is usually accomplished by applying a large number of tubes of small bore, as by this means the maximum heating surface can be obtained in a given area.

Fig. 9 illustrates in diagrammatic form the heater on which the present study is based. This is composed of 320 tubes, one inch (outside diameter), 6 ft. long, with walls .095 in. thick, giving a total heating surface of 407 sq. ft. These tubes are surrounded by a casing through which the smokebox gases circulate. They are fixed at each end into headers, these headers being divided into ten compartments, in each of which are 32 tubes.

The feed water enters the lower compartment of one header, flowing thence through the 32 tubes to the opposite header,

tive Company, we find that the evaporative value of tubes 2 in. diam. 18 and 19 ft. long, is respectively 79.5 and 81 lb. of water per hour. The difference or 1.5 lb. equals the evaporative value of that portion of the tube one foot long which is subjected to a gas temperature of 600 deg.

With steam at 205 lb. pressure and feed water at 60 deg., the B. t. u. content imparted to the water in the boiler, per second, is:

$$\frac{(1,198.5 - 28.08) \times 1.5}{3,600} = .488 \text{ B. t. u.}$$

for the total temperature difference; or a heat transmission of:

$$\frac{.488}{600 - 390} = .002325 \text{ B. t. u.}$$

per second per degree of temperature difference.

The heating surface in one foot of 2 in. boiler tube is .523

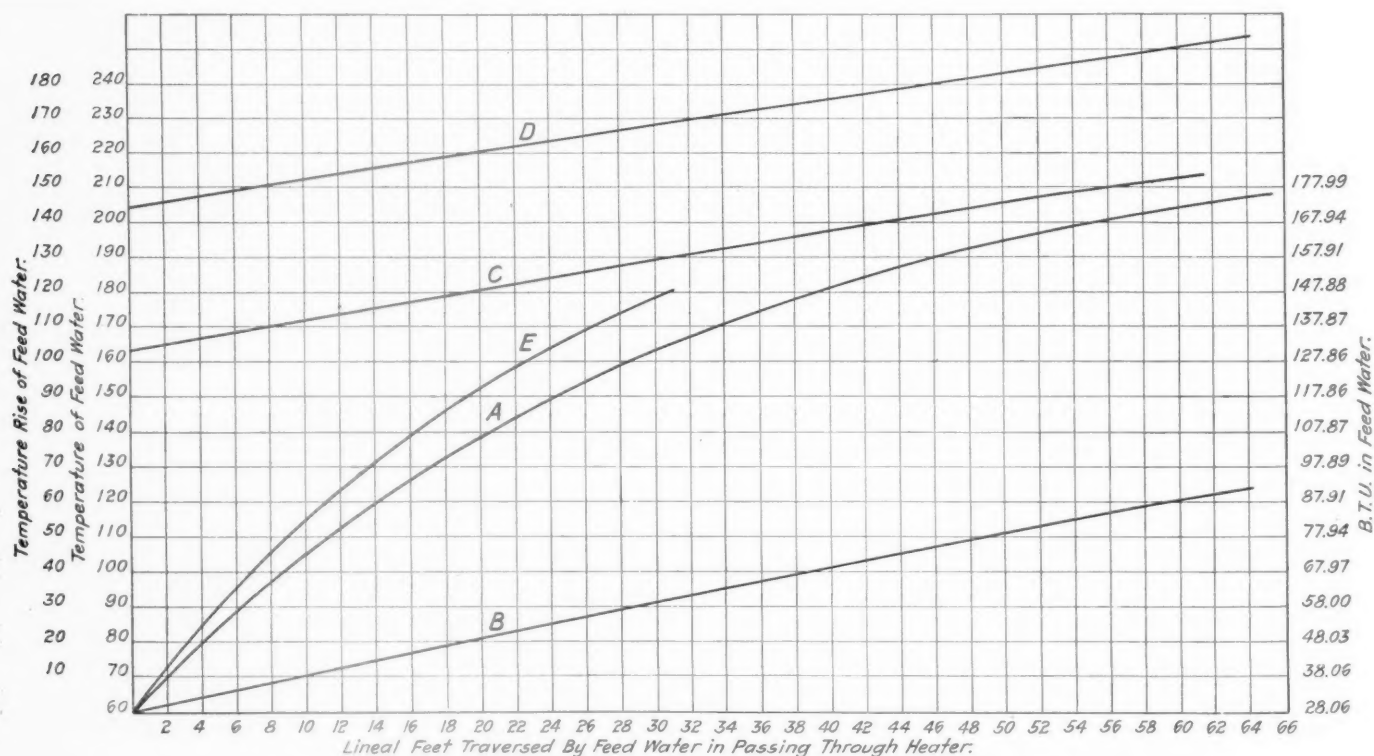


Fig. 6—Rise in Feed Water Temperature Per Lineal Foot of Feed Water Heater Pipes

traversing in this way, the heater, ten times before passing into the boiler.

As a basis for determining the transmission of heat from waste gases into the feed water, we will consider the known evaporative capacity of a boiler tube under similar conditions.

When evaporating 54,400 lb. of water per hour, the locomotive under consideration showed a smokebox temperature of approximately 600 deg., and this temperature will be assumed in the present calculations.

From Bulletin 1017, published by the American Locomo-

sq. ft.; therefore the conductance of the boiler tube is;

$$\frac{.002325}{.523} = .00445 \text{ B. t. u.}$$

per second, per sq. ft. of heating surface, for one degree temperature difference.

From tests made by Geo. L. Fowler, on a Jacobs-Schupert boiler when working at capacity, it was found that the average velocity of the flow of water parallel to the longitudinal center of the boiler, was about .65 ft. per second. This record was obtained at a point near the water leg, but we can assume without serious error, the same velocity at a point 18.5 ft. ahead of the back tube sheet.

*The first part of this article, discussing the exhaust steam method of preheating was published in the December *Railway Mechanical Engineer* on page 645.

The weight of water passing through the feed heater is 15.35 lb. per second; the volume per foot of the 32 tubes forming each pass is .1145 cu. ft. and the weight of water per foot entering the heater is 7.14 lb., the velocity in feet per second through each pass is:

$$\frac{15.35}{7.14} = 2.15 \text{ ft.}$$

Referring again to the experiment of Clement and Garland, Fig. 8 gives the relation found between the velocity of the feed water and the conductance of the metal in the tube plus the film on the water side. It is evident that this conductance is independent of the heating medium and that the low heat transmission with gases is due solely to the high resistance of the film on the gas side. The value of this resistance may be determined by the following method.

Reading from the Fig. 8 we find at a water velocity of .65 ft. per second, a conductance through the tube and water film of .1635 B. t. u. per second. The conductance of the boiler tube has been found to be .00445 B. t. u. As the resistance to heat transfer is the reciprocal of the conductance, we have:

$$\frac{1}{\frac{1}{.00445} + \frac{1}{.1635}} = .00458 \text{ B. t. u.}$$

or the conductance of the film on the gas side.

In the Clement and Garland experiment, the thickness of the tube walls was .134 in. with a conductance through the metal of 1.204 B. t. u. With tubes .095 in. thick, the conductance of the metal is:

$$\frac{1}{6.2 \times .095} = 1.697 \text{ B. t. u.}$$

Referring again to Fig. 8, in which the water film is plotted in relation to the velocity of the feed water, we find, for a water velocity of 2.15 ft. per second, a conductance of .227 B. t. u. Combining this with the conductance of the tube, we have:

$$\frac{1}{\frac{1}{1.697} + \frac{1}{.227}} = .200 \text{ B. t. u.}$$

or the total conductance of a tube .095 thick plus the water film. Carrying this further, knowing the conductance of the gas film, we have:

$$\frac{1}{\frac{1}{.200} + \frac{1}{.00448}} = .00448 \text{ B. t. u.}$$

or the conductance of metal, gas and water films.

Having established the conductance we can now determine the quantity of heat transmitted to the feed water by the proposed heater, using equation (5).

Assuming as in the case of the exhaust steam heater that the feed water enters the heater at a temperature of 60 deg., corresponding to a thermal content of 28.08 B. t. u. and with the average temperature of the heating gases 600 deg., the heat absorbed per lb. of feed water during its traverse through the first pass, or the first six lineal feet, is given by the following equation:

$$\Omega = \frac{k^{\circ} A h m L}{s w'} \quad \dots \dots \dots (8)$$

s = Velocity of water in feet per second.
 w' = Weight of water in L ft. of the heater.
 L = Number of lineal feet through which the heat transfer is in progress.

Using the quantities as determined above:

$$\Omega = \frac{.00448 \times 40.7 \times (600 - 63) \times 6}{2.15 \times 42.84} = 6.37 \text{ B. t. u.}$$

Or at the end of the first pass the heat content of the feed water is $28.08 + 6.37 = 34.45$ B. t. u. corresponding to a temperature of 6.64 deg.

By a similar step by step process it will be found that at the end of the tenth pass or 60 lineal feet, the thermal content of the feed water has risen to 88.76 B.t.u. corresponding to a temperature of 120.7 deg.

This increase in temperature and thermal value is shown graphically by curve *B* in Fig. 6. It will be observed that

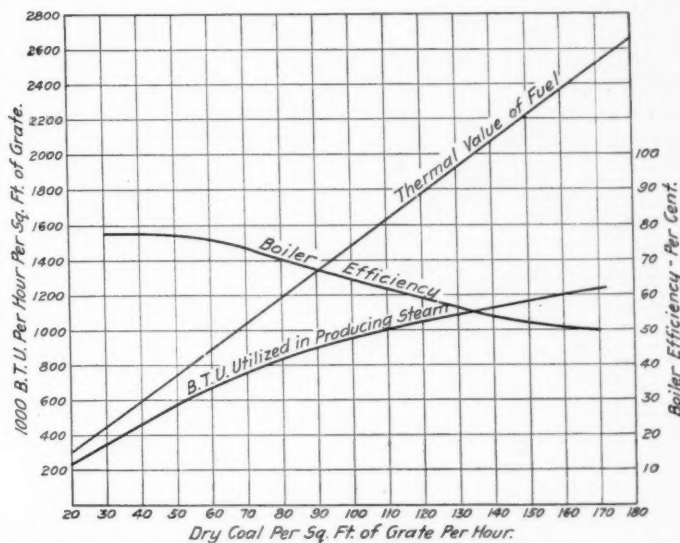


Fig. 7—Efficiency Curves of a Locomotive Boiler Without a Feed Water Heater

this curve is practically a straight line, indicating that in this type of heater the temperature rise is nearly proportional to the heating surface traversed by the feed water.

In the above calculations it has been assumed that the velocity of the gases through the heater will be equal to that through the boiler tubes.

The direct economy obtainable is given by equation (7).

Applying this equation, we find for a heater of the type

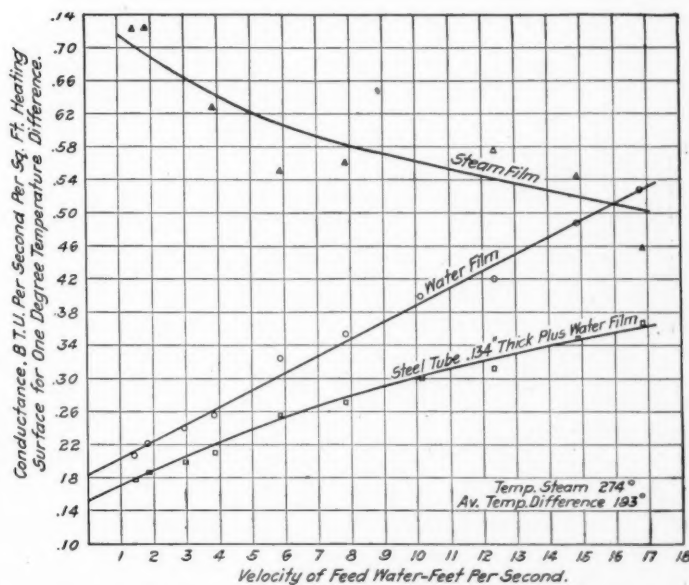


Fig. 8—Conductance Curves for Waste Gas Heater Tubes

and proportions illustrated by Fig. 9, a direct economy of:

$$100 - \frac{1,170.42 - (60.68 - 20.48)}{1,170.42} = 3.4 \text{ per cent.}$$

In these calculations it has been assumed that a feed pump will be used for forcing the water through the heater, using 1.75 per cent of the total amount of steam generated. The direct economy which is obtained by feed water heat-

ing with waste gases reduces the unit fuel consumption to:

$$\frac{120 \times 1,130.2}{1,170.42} = 116 \text{ lb.}$$

Referring to Fig. 7, it will be seen that the ordinate for a unit fuel consumption of 116 lb. crosses the boiler efficiency curve at 60 per cent, as the efficiency when burning 120 lb. is 59 per cent, the indirect economy equals 1 per cent, or a total economy for the waste gas heater of 4.4 per cent.

The relatively great difference in the temperature of the exhaust steam and the smokebox gases makes possible a further economy through arranging the heaters in series with the exhaust steam as the primary and the waste gases as the secondary heating medium. We have seen that the temperature of the feed water issuing from the exhaust heater having 30 lineal feet traverse, is 163.3 deg., with a total thermal content of 131.16 B.t.u. If this water on passing from the exhaust heater is made to traverse the waste gas heater, it will attain a final temperature of 213.65 deg. with a thermal content of 181.65 B.t.u.

This increase in temperature is shown by curve C on Fig. 6; it will be observed that with the decreased temperature head between the waste gases and the feed water, the curve still approximates a straight line.

The direct economy by series heating is:

$$100 - \frac{1,170.42 - (153.57 - 20.48)}{1,170.42} = 11.5 \text{ per cent.}$$

and the fuel consumption is reduced to:

$$\frac{120 \times 1,037.33}{1,170.42} = 106.5 \text{ lb.}$$

From diagram Fig. 7 the ordinate for a unit fuel consumption of 106.5 lb. crosses the curve at an efficiency of 62.7 per cent, or an indirect saving of 3.4 per cent; this, added to the direct economy, equals 15.2 per cent.

By placing the waste gas heater in series with the exhaust

The constant steam consumption of 1.75 per cent, which has been assumed for the feed pump, may be increased when forcing the water through the two heaters in series, in which case the figured economy will be slightly decreased.

Table II presents a summary of the results obtained in this study of the various types of heaters, as compared with a locomotive not so equipped, but fitted with the ordinary injector. It will be observed that with the injector the water

TABLE II

	Without heater	Exhaust steam heater		Waste gas heater	Series heaters. Waste gas and exhaust steam	
		30 lin. ft.	60 lin. ft.	60 lin. ft.	30 lin. ft.	60 lin. ft.
Boiler pressure	205	205	205	205	205	205
Total heating surface in feed heater .....	...	71.2	142.4	407	478.2	549.4
Unit fuel consum. per hour	120	111.5	107.5	116	106.5	102.3
Av. temp. heating medium. ...	230	230	230	600	230-600	230-600
Temp. feed water entering heater .....	...	60	60	60	60	60
Temp. feed water entering boiler	163.9	163.3	204.3	120.7	213.65	250.25
Thermal content feed water entering heater .....	...	28.08	28.08	28.08	28.08	28.08
Thermal content feed water entering boiler	131.7	131.16	172.27	88.76	181.65	218.76
Thermal units gained by heating .....	...	82.60	123.71	40.20	133.09	170.2
Direct economy by heating .....	...	7.2	10.7	3.4	11.5	14.5
Indirect economy by heating .....	...	2.6	3.5	1.0	3.7	5.0
Total economy by heating. ...	...	9.8	14.2	4.4	15.2	19.5
Area exhaust nozzle required	38.19	30.2	30.8	30	30.9	31.3
Diameter of exhaust nozzle required	6.97	6.2	6.26	6.18	6.27	6.32

enters the boiler at practically the same temperature as from the exhaust steam heater having 30 lineal feet traverse, there is, however, with the injector no economic gain, as the heat given up by the steam is equal to the heat given to the feed water plus the external work done; this amounts to a loss in the present instance of approximately .7 per cent. In this table is shown the area of exhaust nozzle required with the various rates of combustion, to produce the necessary draft.

The thermal balance sheet for the exhaust steam heater, having 60 lineal feet traverse, in series with the waste gas heater, is shown in Table III. This gives the percentage of total heat supplied by the boiler and the two heaters, also as divided between the engine and the feed pump, during one

TABLE III

Source of heat	Proportion of total heat supplied	Percentage of total heat supplied			B. t. u. supplied		
		To engine	To pump	To engine and pump	To engine	To pump	To engine and pump
Exhaust steam heater.	144.19	12.31	7,837,747	142,779	7,980,526		
Waste gas heater....	46.49	3.97	2,517,689	46,046	2,563,735		
Boiler	979.74	83.72	53,314,324	971,041	54,285,365		
	1,170.42	100.00	63,669,760	1,159,866	64,829,626		

hour's operation. Instead of the boiler having to supply 63,669,760 B.t.u., as in the injector fed engine, fuel has only to be burned to supply 54,285,365 B.t.u., or a reduction in unit fuel consumption from 120 lb. to 102.3 lb. per sq. ft. of grate per hour.

CONCLUSIONS

Exhaust steam is superior to waste gases as a heating medium due to the low resistance of the steam film to the transmission of heat.

In a heater using exhaust steam the use of copper tubes is to be preferred to steel or iron on account of their higher conductance. Tubes should have walls as thin as is consistent with strength and wearing qualities.

Exhaust steam may be diverted for heating the feed water

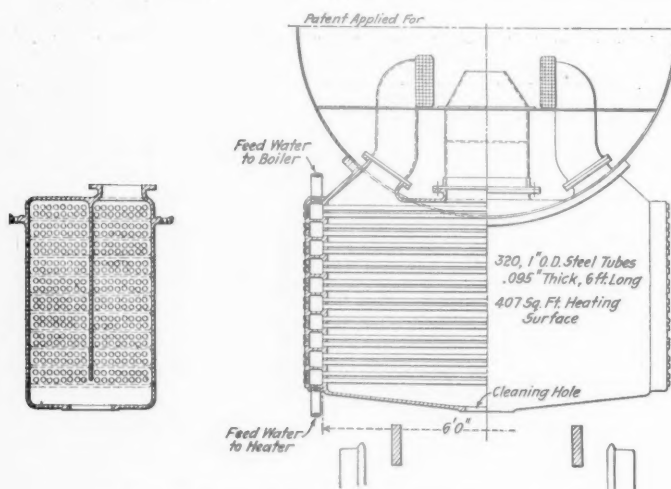


Fig. 9—A Type of Waste Gas Feed Water Heater

heater having a traverse of 60 lineal feet, the temperature of the feed water would be increased to 250.25 deg., and the thermal content to 218.76 B.t.u. The direct economy would be:

$$100 - \frac{1,170.42 - (190.68 - 20.48)}{1,170.42} = 14.5 \text{ per cent.}$$

The unit fuel consumption would be reduced to:

$$\frac{120 \times 1,000.22}{1,170.42} = 102.3 \text{ lb.}$$

From Fig. 7 the ordinate for 102.3 lb. crosses the efficiency curve at 64 per cent, therefore the indirect economy is 5 per cent, and the total economy 19.5 per cent.

without detriment to the operation of the locomotive if the area of the exhaust nozzle is decreased to give the required draft. This can be done without any increase in back pressure on the pistons.

An exhaust steam heater such as is shown by Fig. 7, if fitted with copper tubes, will give an economy in fuel of about 11.8 per cent when using 13 per cent of the exhaust steam.

The economy of the heater using waste gases as a heating medium increases nearly in direct proportion to the heating surface. It is very difficult, however, to find space on a locomotive for a heater giving over 5 per cent economy.

High economy may be obtained by using exhaust steam and waste gases in series, but there is not sufficient room on a modern locomotive for such an application.

It is very desirable that further investigation be made of the heat transmitting property of the gas film.

TABLES FOR COMPUTING THE AREA FOR BOILER LAGGING

BY WILLIAM N. ALLMAN

For the purpose of determining the area in square feet required in lagging for boilers, cylinders or other heated surfaces to be insulated, the tables shown will be found convenient. As it is the general practice of the various lagging manufacturers to furnish lagging in six-inch widths, the tables are computed on this basis. In establishing the area required it will be understood there are perfectly flat

TABLE I

Thickness of lagging	Concave Chord	Convex Chord
3/4 in. to 15/16 in.	6 in.	6 3/16 in.
1 in.	6 in.	6 1/4 in.
1 1/16 in. to 1 7/16 in.	6 in.	6 5/16 in.
1 1/2 in. to 1 15/16 in.	6 in.	6 3/4 in.
2 in.	6 in.	6 7/16 in.
Over 2 in.	6 in.	6 1/2 in.

surfaces, and also curved surfaces to deal with, and naturally, cylindrical or curved surfaces require lagging with curved faces. The thickness of the lagging for the cylindrical sheets is the basis for making the computations and the maximum thickness should always be used. By maximum thickness is meant the thickest end where a tapered

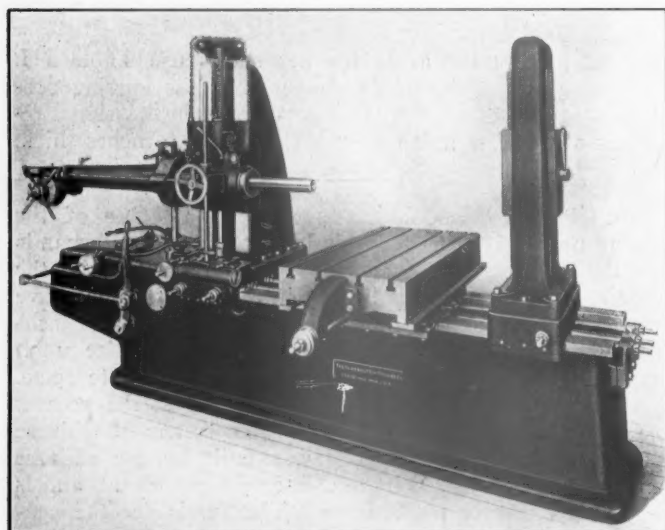
TABLE II—AREAS, IN SQUARE FEET, FOR CONVEX BLOCKS OF VARIOUS RADII

Length in inches	6 3/16 in. wide. Area, sq. ft.	6 1/4 in. wide. Area, sq. ft.	6 5/16 in. wide. Area, sq. ft.	6 3/8 in. wide. Area, sq. ft.	6 7/16 in. wide. Area, sq. ft.	6 1/2 in. wide. Area, sq. ft.
1/64.....	.00067	.00067	.00068	.00069	.00698	.00070
1/32.....	.00134	.00135	.00136	.00138	.00139	.00141
1/16.....	.00269	.00271	.00273	.00276	.00279	.00282
3/32.....	.00537	.00542	.00547	.00553	.00558	.00564
1/8.....	.01074	.01085	.01095	.01106	.01117	.01128
3/16.....	.02148	.02170	.02191	.02213	.02235	.02256
1/4.....	.03223	.03255	.03287	.03320	.03352	.03385
5/16.....	.04297	.04340	.04383	.04427	.04470	.04513
3/8.....	.08593	.08680	.08767	.08854	.08940	.09027
1/2.....	.12890	.13020	.13151	.13281	.13411	.13541
3/4.....	.17187	.17361	.17534	.17708	.17881	.18055
1.....	.21484	.21701	.21918	.22135	.22352	.22569
1 1/16.....	.25781	.26041	.26302	.26562	.26822	.27083
1 1/8.....	.30078	.30381	.30685	.30989	.31293	.31597
1 1/4.....	.34375	.34722	.35069	.35416	.35763	.36111
1 3/8.....	.38671	.39062	.39453	.39843	.40234	.40625
1 1/2.....	.42968	.43402	.43836	.44270	.44704	.45138
1 5/8.....	.47264	.47742	.48220	.48698	.49176	.49654
2.....	.51560	.52080	.52600	.53120	.53640	.54160
2 1/16.....	.55856	.56416	.56976	.57536	.58096	.58656
2 1/8.....	.60152	.60762	.61372	.61982	.62592	.63202
2 1/4.....	.64448	.65108	.65768	.66428	.67088	.67748
2 3/8.....	.68744	.69454	.70164	.70874	.71584	.72294
2 1/2.....	.73000	.73760	.74520	.75280	.76040	.76800
2 5/8.....	.77100	.77910	.78720	.79530	.80340	.81150
3.....	.81960	.82820	.83680	.84540	.85400	.86260
3 1/16.....	.87120	.88040	.88960	.89880	.90800	.91720
3 1/8.....	.92580	.93560	.94540	.95520	.96500	.97480
3 1/4.....	.98360	.99400	1.00000	1.01000	1.02000	1.03000
3 3/8.....	1.04000	1.05000	1.06000	1.07000	1.08000	1.09000
3 1/2.....	1.10000	1.11000	1.12000	1.13000	1.14000	1.15000
3 5/8.....	1.16000	1.17000	1.18000	1.19000	1.20000	1.21000
4.....	1.22000	1.23000	1.24000	1.25000	1.26000	1.27000
4 1/16.....	1.28000	1.29000	1.30000	1.31000	1.32000	1.33000
4 1/8.....	1.34000	1.35000	1.36000	1.37000	1.38000	1.39000
4 1/4.....	1.40000	1.41000	1.42000	1.43000	1.44000	1.45000
4 3/8.....	1.46000	1.47000	1.48000	1.49000	1.50000	1.51000
4 1/2.....	1.52000	1.53000	1.54000	1.55000	1.56000	1.57000
4 5/8.....	1.58000	1.59000	1.60000	1.61000	1.62000	1.63000
5.....	1.64000	1.65000	1.66000	1.67000	1.68000	1.69000
5 1/16.....	1.70000	1.71000	1.72000	1.73000	1.74000	1.75000
5 1/8.....	1.76000	1.77000	1.78000	1.79000	1.80000	1.81000
5 1/4.....	1.82000	1.83000	1.84000	1.85000	1.86000	1.87000
5 3/8.....	1.88000	1.89000	1.90000	1.91000	1.92000	1.93000
5 1/2.....	1.94000	1.95000	1.96000	1.97000	1.98000	1.99000
5 5/8.....	2.00000	2.01000	2.02000	2.03000	2.04000	2.05000
6.....	2.06000	2.07000	2.08000	2.09000	2.10000	2.11000
6 1/16.....	2.12000	2.13000	2.14000	2.15000	2.16000	2.17000
6 1/8.....	2.18000	2.19000	2.20000	2.21000	2.22000	2.23000
6 1/4.....	2.24000	2.25000	2.26000	2.27000	2.28000	2.29000
6 3/8.....	2.30000	2.31000	2.32000	2.33000	2.34000	2.35000
6 1/2.....	2.36000	2.37000	2.38000	2.39000	2.40000	2.41000
6 5/8.....	2.42000	2.43000	2.44000	2.45000	2.46000	2.47000
7.....	2.48000	2.49000	2.50000	2.51000	2.52000	2.53000
7 1/16.....	2.54000	2.55000	2.56000	2.57000	2.58000	2.59000
7 1/8.....	2.60000	2.61000	2.62000	2.63000	2.64000	2.65000
7 1/4.....	2.66000	2.67000	2.68000	2.69000	2.70000	2.71000
7 3/8.....	2.72000	2.73000	2.74000	2.75000	2.76000	2.77000
7 1/2.....	2.78000	2.79000	2.80000	2.81000	2.82000	2.83000
7 5/8.....	2.84000	2.85000	2.86000	2.87000	2.88000	2.89000
8.....	2.90000	2.91000	2.92000	2.93000	2.94000	2.95000
8 1/16.....	2.96000	2.97000	2.98000	2.99000	3.00000	3.01000
8 1/8.....	3.02000	3.03000	3.04000	3.05000	3.06000	3.07000
8 1/4.....	3.08000	3.09000	3.10000	3.11000	3.12000	3.13000
8 3/8.....	3.14000	3.15000	3.16000	3.17000	3.18000	3.19000
8 1/2.....	3.20000	3.21000	3.22000	3.23000	3.24000	3.25000
8 5/8.....	3.26000	3.27000	3.28000	3.29000	3.30000	3.31000
9.....	3.32000	3.33000	3.34000	3.35000	3.36000	3.37000
9 1/16.....	3.38000	3.39000	3.40000	3.41000	3.42000	3.43000
9 1/8.....	3.44000	3.45000	3.46000	3.47000	3.48000	3.49000
9 1/4.....	3.50000	3.51000	3.52000	3.53000	3.54000	3.55000
9 3/8.....	3.56000	3.57000	3.58000	3.59000	3.60000	3.61000
9 1/2.....	3.62000	3.63000	3.64000	3.65000	3.66000	3.67000
9 5/8.....	3.68000	3.69000	3.70000	3.71000	3.72000	3.73000
10.....	3.74000	3.75000	3.76000	3.77000	3.78000	3.79000
10 1/16.....	3.80000	3.81000	3.82000	3.83000	3.84000	3.85000
10 1/8.....	3.86000	3.87000	3.88000	3.89000	3.90000	3.91000
10 1/4.....	3.92000	3.93000	3.94000	3.95000	3.96000	3.97000
10 3/8.....	3.98000	3.99000	4.00000	4.01000	4.02000	4.03000
10 1/2.....	4.04000	4.05000	4.06000	4.07000	4.08000	4.09000
10 5/8.....	4.10000	4.11000	4.12000	4.13000	4.14000	4.15000
11.....	4.16000	4.17000	4.18000	4.19000	4.20000	4.21000
11 1/16.....	4.22000	4.23000	4.24000	4.25000	4.26000	4.27000
11 1/8.....	4.28000	4.29000	4.30000	4.31000	4.32000	4.33000
11 1/4.....	4.34000	4.35000	4.36000	4.37000	4.38000	4.39000
11 3/8.....	4.40000	4.41000	4.42000	4.43000	4.44000	4.45000
11 1/2.....	4.46000	4.47000	4.48000	4.49000	4.50000	4.51000
11 5/8.....	4.52000	4.53000	4.54000	4.55000	4.56000	4.57000
12.....	4.58000	4.59000	4.60000	4.61000	4.62000	4.63000
12 1/16.....	4.64000	4.65000	4.66000	4.67000	4.68000	4.69000
12 1/8.....	4.70000	4.71000	4.72000	4.73000	4.74000	4.75000
12 1/4.....	4.76000	4.77000	4.78000	4.79000	4.80000	4.81000
12 3/8.....	4.82000	4.83000	4.84000	4.85000	4.86000	4.87000
12 1/2.....	4.88000	4.89000	4.90000	4.91000	4.92000	4.93000
12 5/8.....	4.94000	4.95000	4.96000	4.97000	4.98000	4.99000
13.....	5.00000	5.01000	5.02000	5.03000	5.04000	5.05000
13 1/16.....	5.06000	5.07000	5.08000	5.09000	5.10000	5.11000
13 1/8.....	5.12000	5.13000	5.14000	5.15000	5.16000	5.17000
13 1/4.....	5.18000	5.19000	5.20000	5.21000	5.22000	5.23000
13 3/8.....	5.24000	5.25000	5.26000	5.27000	5.28000	5.29000
13 1/2.....	5.30000	5.31000	5.32000	5.33000	5.34000	5.35000
13 5/8.....	5.36000	5.37000	5.38000	5.39000	5.40000	5.41000
14.....	5.42000	5.43000	5.44000	5.45000	5.46000	5.47000
14 1/16.....	5.48000	5.49000	5.50000	5.51000	5.52000	5.53000
14 1/8.....	5.54000	5.55000	5.56000	5.57000	5.58000	5.59000
14 1/4.....	5.60000	5.61000	5.62000	5.63000	5.64000	5.65000
14 3/8.....	5.66000	5.67000	5.68000	5.69000	5.70000	5.71000
14 1/2.....	5.72000	5.73000	5.74000	5.75000	5.76000	5.77000
14 5/8.....	5.78000	5.79000	5.80000	5.81000	5.82000	5.83000
15.....	5.84000	5.85000	5.86000	5.87000	5.88000	5.89000
15 1/16.....	5.90000	5.91000	5.92000	5.93000	5.94000	5.95000
15 1/8.....	5.96000	5.97000	5.98000	5.99000	6.00000	6.01000
15 1/4.....	6.02000	6.03000	6.04000	6.05000	6.06000	6.07000
15 3/8.....	6.08000	6.09000	6.10000	6.11000	6.12000	6.13000
15 1/2.....	6.14000	6.15000	6.16000	6.17000	6.18000	6.19000
15 5/8.....	6.20000	6.21000	6.22000	6.23000	6.24000	6.25000
16.....	6.26000	6.27000	6.28000	6.29000	6.30000	6.31000
16 1/16.....	6.32000	6.33000	6.34000	6.35000	6.36000	6.37000
16 1/8.....	6.38000	6.39000	6.40000	6.41000	6.42000	6.43000
16 1/4.....	6.44000	6.45000	6.46000	6.47000	6.48000	6.49000
16 3/8.....	6.50000	6.51000	6.52000	6.53000	6.54000	6.55000
16 1/2.....	6.56000	6.57000	6.58000	6.59000	6.60000	6.61000
16 5/8.....	6.62000	6.63000	6.64000	6.65000	6.66000	6.67000
17.....	6.68000	6.69000	6.70000	6.71000	6.72000	6.73000
17 1/16.....	6.74000	6.75000	6.76000	6.77000	6.78000	6.79000
17 1/8.....	6.80000	6.81000	6.82000	6.83000	6.84000	6.85000
17 1/4.....	6.86000	6.87000	6.88000	6.89000	6.90000	6.91000
17 3/8.....	6.92000	6.93000	6.94000	6.95000	6.96000	6.97000
17 1/2.....	6.98000	6.99000	7.00000	7.01000	7.02000	7.03000
17 5/8.....	7.04000	7.05000	7.06000	7.07000	7.08000	7.09000
18.....	7.10000	7.11000	7.12000	7.13000	7.14000	7.15000
18 1/16.....	7.16000	7.17000	7.18000	7.19000	7.20000	7.21000
18 1/8.....	7.22000	7.23000	7.24000	7.25000	7.26000	7.27000
18 1/4.....	7.28000	7.29000	7.30000	7.31000	7.32000	7.33000
18 3/8.....	7.34000	7.35000	7.36000	7.37000	7.38000	7.39000
18 1/2.....	7.40000	7.41000	7.42000	7.43000	7.44000	7.45000
18 5/8.....	7.46000	7.47000	7.48000	7.49000	7.50000	7.51000
19.....	7.52000	7.53000	7.54000	7.55000	7.56000	7.57000
19 1/16.....	7.58000	7.59000	7.60000	7.61000	7.62000	7.63000
19 1/8.....	7.64000	7.65000	7.66000	7.67000	7.68000	7.69000
19 1/4.....	7.70000	7.71000	7.72000	7.73000	7.74000	7.75000
19 3/8.....	7.76000	7.77000	7.78000	7.79000	7.80000	7.81000
19 1/2.....	7.82000	7.83000	7.84000	7.85000	7.86000	7.87000
19 5/8.....	7.88000	7.89000	7.90000	7.91000	7.92000	7.93000
20.....	7.94000	7.9				



THE BLOMQUIST-ECK HORIZONTAL BORING MILL

The working efficiency of any horizontal mill and drill depends entirely upon its ability to operate upon all classes of work at the highest speeds and coarsest feeds practicable, and at all times to produce a finished product of dependable accuracy. The Blomquist-Eck Machine Company, Cleveland, Ohio, in designing its new horizontal boring mill, has developed these points to a high degree by combining rigidity, accuracy, a suitable range of selective speeds and



Blomquist-Eck Horizontal Boring Mill

feeds with a high standard of material and workmanship. The various groups of mechanism form complete individual units and any unit can be inspected, removed or replaced without disturbing the alignment or any adjoining unit. The bed or base is of an unusually wide and deep box section, being cast entirely in one piece. The outer walls directly under the column are left intact, without cored openings, which adds greatly in resisting the lines of stress. Chip chutes are provided and so arranged that their walls give added strength. The bed (directly under the column) is reinforced by sections tied together and cast integral with the base. The bed is further reinforced by heavy deep ribs running lengthwise, and at right angles the three-point support or bearing is also incorporated in the construction.

The column is of a rigid box section, strongly braced internally by ribs in both horizontal and vertical positions. The base of the column has a liberal bearing upon the bed, eliminating deflections and spring.

The spindle saddle is designed with a liberal bearing surface on the face of the column, a long narrow guiding edge with single screw adjustable taper gib for adjustments on one

side and square lock form with gib on the other side. The center of the spindle in the spindle saddle is placed as close to the column face (reducing overhang to a minimum) without sacrificing strength at a point most desired. The elevating screw which is between the column faces and the spindle, is so placed in relation to the narrow guide that the vertical movement of the saddle is direct and accurate. The units comprising the spindle and saddle are counterbalanced by a weight within the column.

The spindle is made from carefully selected high carbon steel, heat-treated, and is ground for its entire length. It is bored for a No. 5 Morse taper and is provided with an end thrust for operating in either direction. The spindle sleeve consists of a special hammered high carbon steel forging accurately ground inside and out. The front and rear spindle sleeve bearings are adjustable and tapered, being made of genuine government bronze. Either bearing can be adjusted



End View of Blomquist-Eck Horizontal Boring Mill

to compensate for wear. Sight feed oil cups provide an adequate lubrication.

The boring bar support is raised or lowered in unison with the spindle saddle by a shaft and a set of planed steel bevel gears. The bar support or bearing proper is securely clamped by a lever binding bolt at any position.

The Method of Driving.—The close-coupled drive gear shafts, mounted on S. K. F. double-row, self-aligning ball bearings, transmit the power to the spindle in a direct and

practical manner. All shafts are made of high carbon steel. Hardened steel ring spur gears, heat treated, are used wherever possible, and these are shrunk onto cast-iron hubs. The smaller spur gears in the drive are made of solid steel and heat treated. The bevel gears are made of hammered steel forgings planed from the solid. The speed changes are made by two levers at the front of the machine which operate the selective sliding gears. The entire driving mechanism is well located on the base and each individual shaft and bearing can be removed or replaced without disturbing any adjoining unit. Access to the entire unit may be had through an oil-tight top-plate cover, the removal of which permits an easy inspection when required. All gears run in a bath of oil, and in addition a positive cascade oiling system is provided for both gears and bearings.

The feed to the spindle in either direction, to the spindle saddle in raising or lowering upon the column, to the table saddle paralleling the bed, or to the table longitudinally upon its saddle, is introduced in the same direct positive geared manner as applied to the spindle drive. Shafts are made of high carbon steel mounted on S.K.F. ball bearings. The gears are of steel and heat treated. The feed mechanism in the base is arranged so any unit may be removed or replaced without disturbing any adjoining unit. All gears run in a bath of oil, and in addition a positive cascade oiling system is provided for bearings and shafts. The feed changes are made by two levers which are placed directly in front and at the top of the gear box. In addition there are three selective interlocking levers provided that engage either the spindle, vertical or table feeds. No two conflicting feeds can be engaged at the same time. In operating star feed facing heads or work of similar nature all feed levers can be positively locked in a neutral position.

Following are the principal dimensions of the machine:

Table and Saddle—The bed surfaces are designed and proportioned to compensate for any overhang of the table at the extreme front or rear positions. When the table is in either extreme position it is supported in the saddle practically three-fourths of its entire length. The saddle is gibbed to the bed by the square lock method having a long, narrow guiding edge with a taper gib for adjustment. The table is of an extra heavy pattern, long, wide and deep, being reinforced by heavy ribs. The table is securely gibbed by the square lock method, which in this instance resists any strains when the table is in an overhanging position.

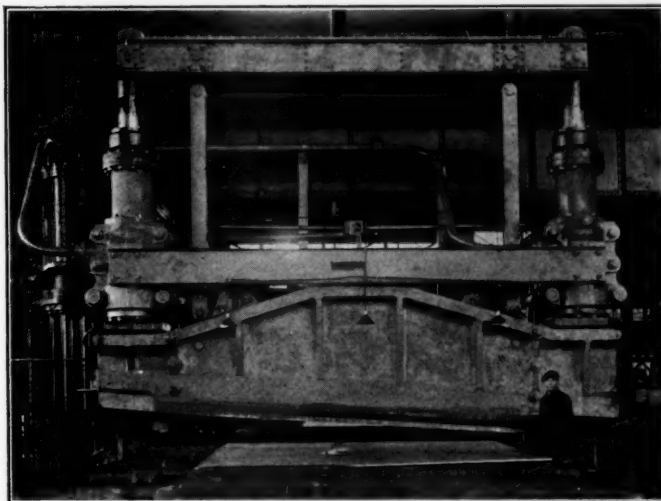
Power rapid traverse of a friction type is provided for all members operated by the feed. Regardless of whatever feed may be engaged, the rapid traverse always operates at one rate of speed in either direction. An adjustable safety friction leather washer in the clutch mechanism prohibits damaging any portion of the mechanism engaged. The clutch control is sensitive, and practically any amount of travel can be had. Hand adjustments to the spindle saddle, spindle travel, table saddle or table are provided in addition to the automatic feeds. All screws are fitted with graduated dials reading in thousandths of an inch.

Single friction clutch pulley drive operating at constant speed is regularly furnished. Constant speed or adjustable speed motor drive can be furnished. Any type of electrical control can be provided.

Diameter of spindle.....	3 1/4 in.
Travel of spindle.....	30 in.
Number of spindle speed changes.....	12
Range of spindle speeds in r.p.m.....	16 to 196
Number of feed changes to spindle or table.....	9
Number of feed changes to spindle or table with back gears.....	18
Ranges of feed in inches per each revolution of spindle.....	.003 in. to .518 in.
Working surface of table.....	24 in. by 54 in.
Automatic longitudinal feed to table.....	36 in.
Automatic transverse feed or parallel movement of table with bed.....	37 in.
Maximum distance spindle nose to outboard bearing.....	5 ft. 5 in.
Maximum distance top of plain working table to center of spindle.....	27 in.
Diameter constant speed friction drive pulley.....	14 in.
Width of driving belt.....	4 in.
Weight crated domestic shipment (standard length) Approx.....	11,600 lb.
Size of motor recommended.....	5 hp.

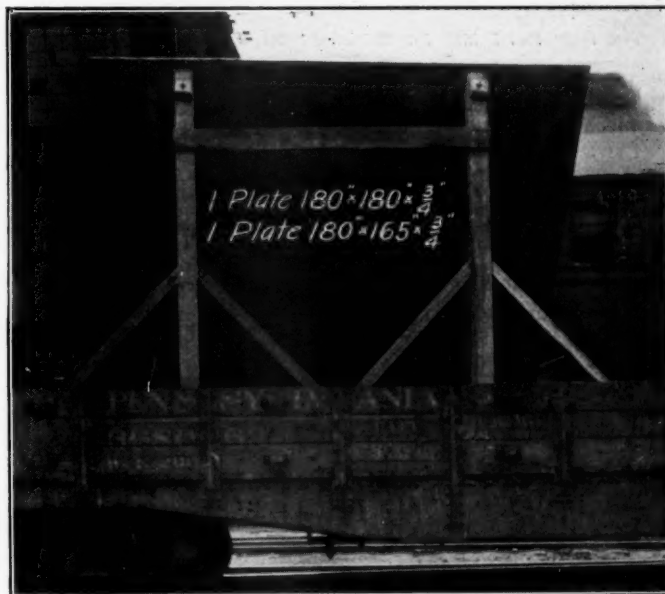
THE LARGEST PLATE MILL IN THE WORLD

The Lukens Steel Company, Coatesville, Pa., has for the fourth time in its history the largest plate mill in the United States. This company, at whose plant the first boiler plate in America was made in about 1820, had in 1890 a 120-in. plate mill, which was later rebuilt to the 134-in. size; in 1903 a 140-in. unit was placed in service, and now with its 204-in. No. 5 mill it has for the fourth time the largest



Hydraulic Shears 210 in. Between Housings, Having Capacity for 2-in. Plate

mill in the United States. This mill also exceeds anything in any other country, exceeding the 178-in. mill of the Witkowitz Works in Austria and the 168-in. mill in the British Isles. This new mill is capable of rolling plates up to 192-in. in width and circular pieces a few inches wider, with comparatively little variation in the gage at the center of the

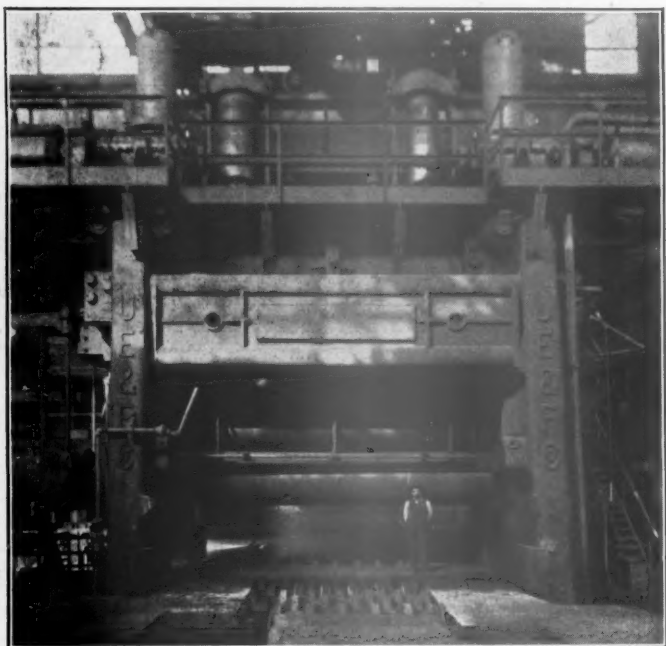


Two Plates of Locomotive Firebox Steel Ready for Shipment to the Pennsylvania Railroad

plate. A novel device for handling and weighing the plates after shearing, designed by C. L. Huston, vice-president and mechanical engineer of the Lukens Steel Company, has been installed, and further devices are being planned to eliminate almost entirely all hand labor about the shearing department and to more accurately cut the plates than has been possible

by methods heretofore in general use. Facilities have also been provided for flanging heads in one piece. For 15-ft. boilers the entire head is heated and flanged at one time, the work being done by the rolling process, which provides a better head than when heads of such diameter are made in two pieces.

When the construction of this large mill was contemplated attempts were made to build a 180-in. three-high mill after the accepted American practice. When it came to obtaining the chilled rolls of the size and weight desired, however, there was no manufacturer to be found in this country who could be persuaded to undertake the contract. Such a mill required chilled rolls of 50 in. in diameter, which was larger than anything the rollmakers had ever attempted. To overcome



The New No. 5 Mill for 192-in. Plates, Lukens Steel Company

this difficulty Mr. Huston proposed the adoption of the four-high reversing type of mill, the design of which was carried out in collaboration with the engineering staff of the United Engineering & Foundry Company. This new mill is built on the principle of the two-high reversing plate stand commonly used in the British Isles, being modified by having two large supporting rolls to back up the two finishing rolls in order to stiffen the mill and give it added strength to prevent the operating rolls from springing when wider than plates are being handled. This arrangement enables the use of operating rolls of smaller diameter and thereby overcomes the difficulty of obtaining the large chilled rolls. These operating rolls are 34 in. in diameter and have a working face of 204 in. with 27-in. necks. They weigh about 30 tons each. The 50-in. diameter backing rolls are made of cast steel, with 36-in. necks and weigh about 60 tons each.

It was necessary to use a housing of a built-up type, as it is so large that the machining and transportation of such a housing cast in one piece would be impossible. Each housing weighs 400,000 lb. The mill stands about 40 ft. from the top of the screw cover to the bottom of the shoes, and is slightly over 42 ft. in height over all. The foundation of the mill is of concrete built on solid rock. The screw-down rig is driven by 150-hp. motors, one on each housing. The mill pinions are of cast steel, having a 42-in. pitch diameter and a 60-in. face. These pinions are connected to the working rolls by spindles 20 ft. long. Special provision was made for removing the smaller chilled rolls for grinding, which is done in a special grinding machine built by the Norton Com-

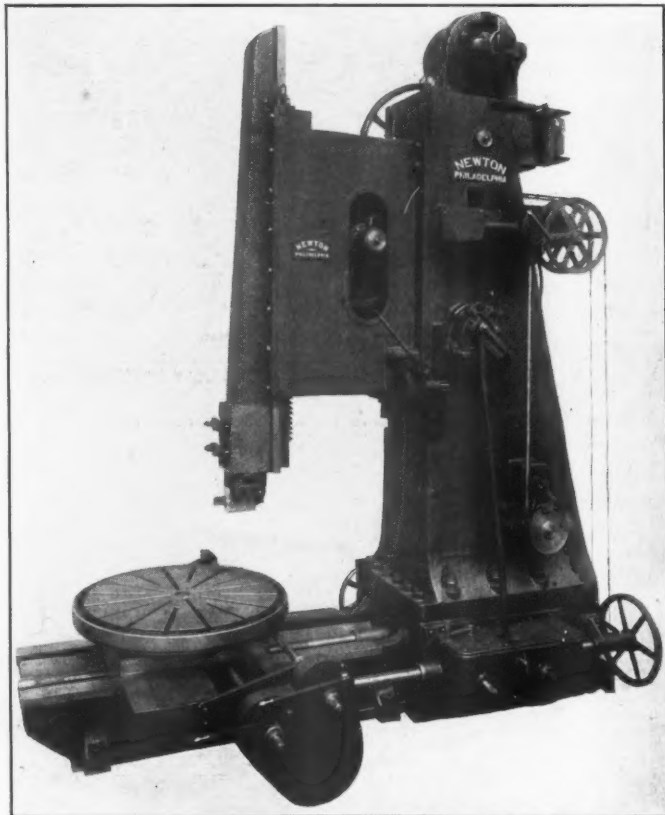
pany, the largest grinder ever built for this class of work.

The mill is driven by a 46-in. and 70-in. by 60-in. twin tandem compound condensing engine fitted with a jack-shaft and gear ratio of one to two. This engine was designed and constructed by the Mesta Machine Company. The plates after being rolled pass over the turnout table, 65 ft. long, to the straightening rolls, which were furnished by the Hilles and Jones Company after Mr. Huston's design. An inspection tilt-up device for raising the plates so that the bottom side may be inspected is provided, being operated by hydraulic cylinders. After inspections the plates are conveyed to the cut-off shear, which is hydraulically operated and which is 210 in. between housings.

The mill will handle ingots up to 60,000 lb. in weight. When it is operated to full capacity it is estimated that it will roll from 4,000 to 5,000 tons per week. To supply the increased metal to operate this new mill an addition to the steel plate mill of six basic open-hearth furnaces of 100 tons capacity each, has just been finished. With the other furnaces in operation and an additional two more which are contemplated, the Lukens Steel Company will have an estimated annual capacity of about 500,000 tons of finished plate. This company furnishes the majority of railroad locomotive boiler steel used in this country.

UPRIGHT GENERATING PLANERS

The Newton Machine Tool works, Inc., Philadelphia, Pa., having found that the term "slotting machine" does not suggest the possibilities of its equipment formerly known under that name, has called its latest design, which has recently been placed on the market, "upright generating



Newton Upright Generating Planer

planer." This machine, which is shown in the illustrations, has a stroke of 72 in., other sizes being built down to 36-in. maximum stroke. These machines are rack driven and are provided with a newly developed method of stroke control

disk, a close-up view of which is included with this article. The trips on this control disk can be operated by hand while the machines are in motion, which is desirable as the drift of the motor has to be compensated for.

This machine represents an entirely new development. It is rigid, conveniently controlled and is designed to insure permanency of alignment. The rams or cutter bars are counterweighted, having square bearings in the guides with taper side adjusting shoe and, on all sizes, the vertical clamping surface is solid and steel faced and equipped with suitable tool holding clamps. Beneath the ram or cutter bar is mounted a newly developed steel swiveling relief tool box apron, which can operate in any position of a complete circle.

The motion is transmitted from the motor to the broad face steel rack on back of the cutter-bar or ram through all steel spur reduction gears, whose coarseness of pitch and width of face increase with reduction of the gear speed. All gears are covered and on the operating side of machines, all gears are totally enclosed. The circular tables are heavily ribbed and of substantial construction and have full bearing on the saddle to which they are held by corner clamps. These tables are centered by a deep face, large diameter bearing. The oil pans are cast solid with circular tables and are graduated on the exterior into 360 degrees. The table saddles have narrow guide alignment control with centralized location of feed screw and taper shoe control of fit. Hand adjustment of the saddle is provided for from both ends of the cross slide.

All feed motions are independently clutched and the clutches have independent levers. The cross slide is of

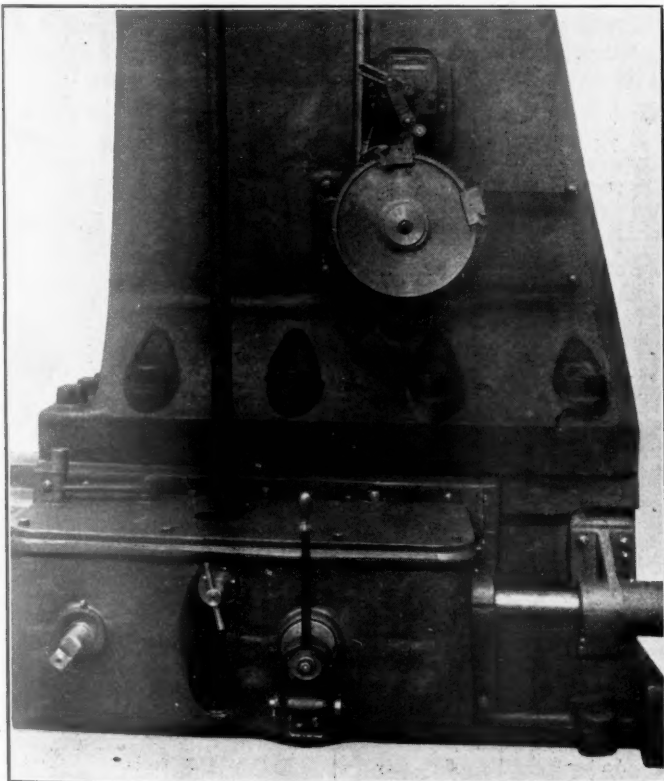
screw is located. The circular, cross and longitudinal feeds are variable in rate and reversible through the use of pawl and ratchet wheel.

The cutter bar guide on the 36-inch stroke machine is cast solid with frame, and, therefore, does not have any vertical adjustment, while on the 56-inch to 72-inch machines inclusive, they are separate from the frame and have vertical hand-controlled adjustment to permit their being located in positions relative to cutter bars. The cutter bar guide adjusting mechanism is of tandem design to prevent dropping of guide in event of accidental breakage of counterweight ropes.

These upright generating planers are now built for reversing planer type motor drive only. The motor speed should be between 400 and 1,200 R. P. M. and the ratio should preferably be 3 to 1. Rapid traverse for table motions, can be provided as an extra, when desired, through incorporation of suitable mechanism and use of extra constant speed motor.

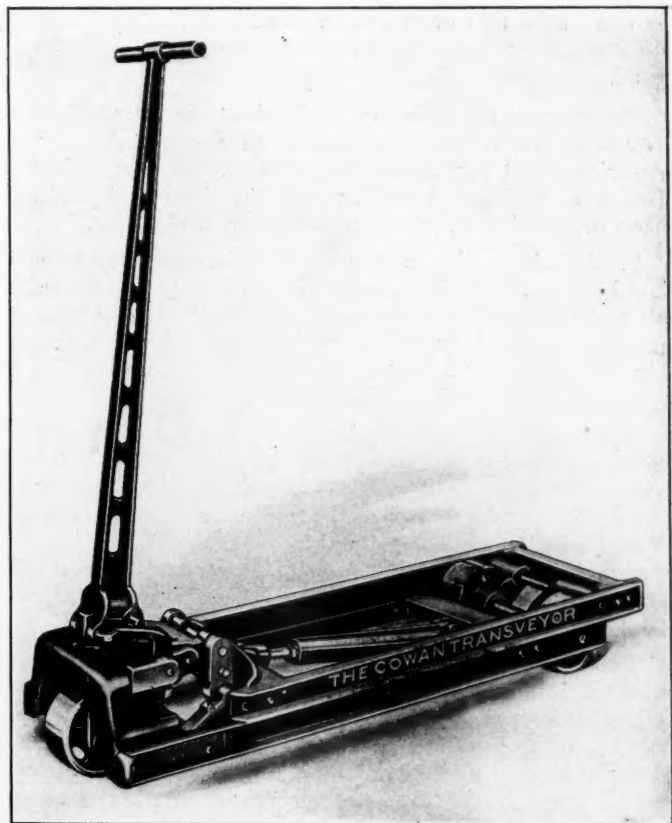
NEW TYPE OF TRANSVEYOR

The latest addition to the line of transveyors manufactured by the Cowan Truck Company, Holyoke, Mass., is its new Model G. This transveyor is of rugged construction and is an easy elevating machine. The leverage is



Stroke Control Disc for Newton Upright Generating Planer

heavy box type section and has square bearings on the base with side adjustment taper shoe. Adjustment is from operating side, as well as from front of machine. The feed screws have bearings on each end to insure operation in tension. The feed motion is taken from a rocking friction box on the outside of which the pawl rod stroke adjusting



Cowan Type G Transveyor

such that the maximum load can be readily elevated by one man. It is made in several sizes varying in capacity from 1,000 to 3,000 lb. It is fitted with an improved locking device. This was chiefly designed to safeguard against the load becoming unseated when trucking over uneven floors. Various other improvements are incorporated in this new machine. The ease with which this transveyor elevates its maximum load, and its quick operation makes it particularly applicable to plants whose trucking requirements demand trucks of the above mentioned capacities.

Railway Mechanical Engineer

(Formerly the RAILWAY AGE GAZETTE, MECHANICAL EDITION
with which the AMERICAN ENGINEER was incorporated)

PUBLISHED ON THE FIRST THURSDAY OF EVERY MONTH BY THE
SIMMONS-BOARDMAN PUBLISHING COMPANY

EDWARD A. SIMMONS, *President* HENRY LEE, *Vice-President and Treasurer*
L. B. SHERMAN, *Vice-President* M. H. WIUM, *Secretary*
WOOLWORTH BUILDING, NEW YORK, N. Y.
F. H. THOMPSON, *Business Manager*, CHICAGO.

Chicago: Transportation Bldg. Cleveland: Citizens' Bldg.
Washington: Home Life Bldg.
London: Queen Anne's Chambers, Westminster.

ROY V. WRIGHT, *Editor*
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C. B. PECK, *Associate Editor* A. F. STUEBING, *Associate Editor*
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Entered at the Post Office at New York, N. Y., as mail matter of the second class.

Subscriptions payable in advance and postage free; United States, Canada and Mexico, \$2.00 a year; Foreign Countries, \$3.00 a year; Single Copy, 20 cents.

WE GUARANTEE, that of this issue 7,400 copies were printed; that of these 7,400 copies 6,348 were mailed to regular paid subscribers, 57 were provided for counter and news company sales, 186 were mailed to advertisers, 66 were mailed to employes and correspondents, and 743 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 7,400, an average of 7,400 copies a month.

THE RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

Employees of the Pennsylvania Railroad furloughed for military service, up to November 1, numbered 24,712, and it is announced that every one of these who returns honorably discharged can have his former position or another equally good.

Government regulation of steel prices was discontinued on December 31, following a meeting of the committee of the American Iron and Steel Institute with the War Industries Board in Washington on December 11. The steel producers have proposed a voluntary reduction in steel prices.

S. M. Felton, who as director general of military railways has had charge of the organization and despatch abroad of all railway forces and the purchase of all railway material for the American Expeditionary Forces, resigned on December 31, and will return to his railroad work at Chicago as president of the Chicago Great Western.

The Fuel Administration has in preparation a compilation of all rules and regulations promulgated during the life of the administration. This will be brought down to date January 1, 1919, and will be issued as soon thereafter as possible. It will be a bound volume of perhaps 500 pages. All persons desirous of obtaining a copy of this should communicate at once with the Bureau of Education, Washington, D. C.

The Professional Division of the United States Department of Labor, office at 16 East 42d street, New York City, invites employers of all classes who want university graduates in mechanical, electrical and civil engineering, and in chemistry, to make use of the facilities of that office in securing men who are retiring from the army or the navy. J. O. Winslow, special agent, in charge of the office, is making a list of en-

gineers and other technically qualified men who are retiring from the military service and desires to have the names of all men of this class seeking employment. The record of each man is carefully investigated before registration.

The Engineering Index, published for 25 years in The Engineering Magazine and its successor, Industrial Management, an index to engineering periodical literature, has been acquired by the American Society of Mechanical Engineers, and hereafter will be compiled and published by this society. The first issue of the Index under its new management appears in the January number of The Journal. As heretofore, The Engineering Index will be regularly issued in three different forms: (1) As a part of The Journal of the Society; (2) as a separate monthly publication for libraries or individuals desiring to clip the items for indexing purposes, and (3) as an annual volume in which all the items for the year are collected.

MEETINGS AND CONVENTIONS

Railway Storekeepers' Association.—The fourteenth annual business meeting of the Railway Storekeepers' Association will be held at the Hotel Sherman, Chicago, on January 27, 28 and 29, 1919. The following subjects will be discussed at this meeting:

Fundamental principles of railway storekeeping, H. C. Pearce.
Unapplied material, committee report, W. D. Stokes.
Labor and labor saving devices, J. R. Mulroy.
Scrap and scrap handling, W. F. Jones.
The use, inspection and handling of lumber and cross-ties, M. E. Towner.
Conservation of material, J. G. Stuart.
Conservation of Cars, H. E. Ray.
Accounting for materials in the stores department, J. H. Waterman, H. E. Ray and U. K. Hall.

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Jan. 14	The Preservation of Ties.....	H. K. Wicksteed....	James Powell....	P. O. Box 7, St. Lambert, Que.
Central	Jan. 10	Fuel Conservation. Election of Officers...	V. C. Randolph....	Harry D. Vought.	95 Liberty St., New York.
Cincinnati	Feb. 11	.....	.....	H. Boutet	101 Carew Bldg., Cincinnati, Ohio.
New England.....	Jan. 14	Acetylene Welding	W. L. Bean.....	W. E. Cade, Jr....	683 Atlantic Ave., Boston, Mass.
New York.....	Jan. 17	Organization and Work of the Engineering and Maintenance Department of the Division of Operation .....	.....	.....	.....
Pittsburgh	Jan. 23	U. S. Naval Batteries in France, illustrated by lantern slides. Luncheon following business session	C. A. Morse.....	Harry D. Vought.	95 Liberty St., New York.
St. Louis.....	Jan. 10	.....	Lt. Com. D. C. Buell.	J. D. Conway....	515 Grandview Ave., Pittsburgh, Pa.
Western	Jan. 20	An Efficient Use of Power Plants.....	Edmund Burke	B. W. Frauenthal.	Union Station, St. Louis, Mo.
				A. F. Stuebing...	750 Transportation Bldg., Chicago.

Air Brake Association.—At a meeting of the executive committee of the Air Brake Association, held on December 5, in Pittsburgh, Pa., it was arranged to hold the 26th annual convention in Chicago on May 6, 7 and 8, 1919. The subjects adopted by the committee for discussion are as follows:

"Air Requirements for Pneumatically Operated Devices for Locomotives," C. H. Weaver, chairman.
 "Cleaning, Repairing, Lubricating and Testing Freight Car Brake Cylinders," by Mark Purcell.
 "Reclamation and Conservation of Material," T. L. Burton, chairman.
 "Twenty Per Cent Overload Allowed on Heavy Grade Braking," by C. H. Rawlings.
 "Holding Standing Trains and Cars on Grades," by R. J. Watters.
 "Recommended Practice Report," H. A. Clark, chairman.
 "M. C. B. Air Brake Defect Card."
 "How Can Enginemen and Trainmen assist in Air Brake Maintenance," by H. A. Glick.

It was decided to invite car and locomotive builders each to send a representative to the convention for their information as to the best methods of installing air brake equipment.

June Mechanical Conventions.—At the meeting of the executive committees of the American Railway Master Mechanics' Association, the Railway Master Car Builders' Association, and the Railway Supply Manufacturers' Association at the Hotel Biltmore, New York, on December 20, arrangements were made for the holding of a mechanical convention at Atlantic City in June. Inasmuch as the convention is a postponed one, the previous decision to meet at Atlantic City was adhered to and the dates set are June 18 to June 25; the Master Car Builders' Association being held first, June 18 to 21, and the Master Mechanics' Association from June 23 to 25. While the executive committees felt that it would be advisable to hold all the sessions during one calendar week, it was not found feasible to make such an arrangement. Frank McManamy, assistant director, Division of Operation of the Railroad Administration, was present. The decision in favor of holding the usual exhibit of the Railway Supply Manufacturers' Association was strongly favored by all those present, the advantages to the younger men in railroad service and for visitors from other countries being very strongly presented. It was decided that all three associations unite in invitations to the representatives of foreign countries to attend the convention.

Headquarters, as in former years, will be in the Marlborough-Blenheim Hotel, and sessions will be held on the Million Dollar Pier. At a separate meeting of the executive committee of the Railway Supply Manufacturers' Association J. D. Conway was elected secretary-treasurer.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Convention, May 6-8, 1919, Chicago.
AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.
AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—V. R. Hawthorne, 746 Transportation Bldg., Chicago. Convention, June 23-25, 1919, Atlantic City, N. J.
AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—R. D. Fletcher, Belt Railway, Chicago.
AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.
ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.
CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 Lawlor Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.
CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. R. McMunn, New York Central, Albany, N. Y.
INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, C. H. & D., Lima, Ohio.
INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.
INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.
MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York.
MASTER CAR BUILDERS' ASSOCIATION.—V. R. Hawthorne, 746 Transportation Bldg., Chicago. Convention, June 18-21, Atlantic City, N. J.
MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass.
NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.
RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio. Convention, January 27-29, 1919, Hotel Sherman, Chicago.
TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

PERSONAL MENTION

GENERAL

E. LANGHAM, general purchasing agent of the Canadian Northern Railway System, has had his jurisdiction extended to include all the Canadian Government Lines, with headquarters in Toronto, Ont.

GEORGE E. MURRAY, whose appointment as electrical and mechanical engineer of the Grand Trunk Western Lines, with headquarters at Battle Creek, Mich., has been announced in these columns, was born on December 8, 1884, at Decatur, Ill. He began railway work with the Wabash in 1903, and two years later went with the People's Gas & Electric Company, of Defiance, Ohio. He returned to the Wabash in 1906 to install the machinery and equipment in the new car shops at Decatur, remaining with that road until 1910. He then became connected with the Chicago & North Western, where he had charge of electrical equipment in shops, and subsequently was made chief electrician of that road, which position he held until he recently went with the Grand Trunk Western Lines, as noted above.

R. D. QUICKEL, having been released from military service, has been reappointed fuel agent of the Southern Railroad and associated roads, lines west, with headquarters at Cincinnati, Ohio, succeeding N. C. Kieffer, assigned to other duties.

SAMUEL J. HUNGERFORD, general manager, eastern lines, of the Canadian Northern, has been appointed assistant vice-president of the Canadian Northern Railway System and the Canadian Government Railways, with headquarters at Toronto, Ont. Mr. Hungerford was born on July 16, 1872, near Bedford, Que. He was educated in the common and high schools and began railway work in May, 1886, as a machinist apprentice on the South Eastern and later served with its successor, the Canadian Pacific, at Farnham, Que. He was then machinist at various places in Quebec, Ontario and Vermont. From August, 1897, to February,



S. J. Hungerford

1903, he was consecutively chargeman, at Montreal; assistant foreman at Farnham, Que., locomotive foreman at Megantic, general foreman at McAdam Junction, N. B., and locomotive foreman at Cranbrook, B. C., on the Canadian Pacific. In February, 1903, he was appointed master mechanic on the Western division at Calgary, Alta. The following January he became superintendent of locomotive shops at Winnipeg, Man., and four years later was appointed superintendent of shops at the same place. In March, 1910, he became superintendent of rolling stock of the Canadian Northern and the Duluth, Winnipeg & Pacific, at Winnipeg, Man., and in May, 1915, was transferred in the same capacity to the Canadian Northern at Toronto, Ont. On November 1, 1917, he was appointed general manager, eastern lines, of the Canadian Northern, which position he held at the time of his recent appointment.

JAMES H. RADER, gang foreman of the Atchison, Topeka & Santa Fe at Emporia, Kans., has been appointed apprentice instructor in charge of schools at La Junta and Pueblo, Colo. His headquarters are at La Junta. Mr. Rader entered the employ of the Santa Fe about nine years ago as a machinist apprentice. After serving his apprenticeship he worked as a machinist until February 26, 1917, when he was appointed assistant apprentice school instructor at Topeka, Kans., and on May 1, 1917, he became gang foreman at Emporia.

W. L. ROBINSON, supervisor of fuel consumption of the Baltimore & Ohio, Western Lines, Dayton & Union, and the Dayton Union Railroad, has been appointed superintendent of fuel and locomotive performance, and his former position has been abolished.

G. W. SEIDEL, superintendent of motive power and rolling stock of the Minneapolis & St. Louis, has been appointed superintendent of motive power of the Chicago & Alton and the Chicago, Peoria & St. Louis, with office at Bloomington, Ill., succeeding J. E. Ohearne, resigned.

C. D. YOUNG, formerly superintendent of motive power of the Pennsylvania Railroad, eastern lines, with office at Wilmington, Del., has been appointed acting superintendent of the Schuylkill division, succeeding William Elmer. Mr. Young resigned in November, 1918, as superintendent of motive power to become a lieutenant-colonel in the transportation corps, engineers.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

C. A. FISHER, a locomotive engineman on the Spokane division of the Great Northern, has been promoted to road foreman of engines of the first district, Spokane division, with headquarters in Hillyard, Wash.

G. R. GALLOWAY, master mechanic of the Baltimore & Ohio, at Lorain, Ohio, has been appointed general master mechanic of the Baltimore & Ohio, Western Lines; the Dayton & Union, and the Dayton Union Railroad, with office at Cincinnati, Ohio, succeeding P. H. Reeves, assigned other duties.

M. A. GLEESON, master mechanic of the Baltimore & Ohio, Western Lines, at New Castle Junction, Pa., has been appointed master mechanic of the Cleveland division, with office at Lorain, Ohio, succeeding G. R. Galloway.

ERIK W. LOSTROM has been appointed road foreman of engines of the Northern Pacific, with office at Duluth, Minn., succeeding Charles Emerson, promoted.

T. F. PERKINSON, master mechanic of the Baltimore & Ohio, with headquarters at Baltimore, Md., has been transferred to Cumberland, Md., as master mechanic.

ZILL PIERCE has been appointed master mechanic of the Saratoga and Champlain divisions of the Delaware & Hudson, with headquarters at Colonie, N. Y., succeeding A. L. Moler, resigned.

J. A. TSCHOUR, general foreman in the locomotive department of the Baltimore & Ohio, Western Lines, at Willard, Ohio, has been appointed master mechanic of the New Castle division, with office at New Castle Junction, Pa., succeeding M. A. Gleeson.

CHARLES W. WEAKS has been appointed road foreman of engines on the Toledo division of the Pennsylvania Lines West, with headquarters at Toledo, Ohio, succeeding R. Palmer, promoted.

CAR DEPARTMENT

M. H. QUINN has been appointed general car foreman of the Erie lines east.

R. B. FREEMAN, car foreman of the Seaboard Air Line, with office at Monroe, N. C., has been appointed general car foreman, with office at Hamlet, N. C.

G. E. SMART, superintendent of the car department of the Canadian Northern Railway System, has been appointed general master car builder, with jurisdiction over all lines of the Canadian Northern and the Canadian Government Railways, with office at Toronto, Ontario.

G. M. WADDY, general foreman of the Erie at the Buffalo car shops, has been appointed general car foreman of the lines west.

SHOP AND ENGINEHOUSE

J. B. TYNAN has been appointed superintendent of the locomotive shops of the Wheeling & Lake Erie at Brewster, Ohio.

PURCHASING AND STOREKEEPING

R. C. HARRIS, supervising engineer for the Pennsylvania Railroad, Western Lines, at Columbus, Ohio, has been appointed general storekeeper, with headquarters at Pittsburgh, Pa.

C. W. KINNEAR, assistant engineer of motive power of the Pennsylvania Lines West at Toledo, Ohio, has been appointed assistant general storekeeper, with office at Pittsburgh, Pa.

C. H. ROTHGERY has been appointed storekeeper of the Baltimore & Ohio, Western Lines, with headquarters at Lorain, Ohio, succeeding W. H. Dean, transferred.

FEDERAL ADMINISTRATION APPOINTMENTS

S. A. BRAMLETTE has been appointed representative of the Division of Labor of the Railroad Administration, with office at Washington, D. C. Mr. Bramlette will be assigned to conduct investigations and to represent the Division of Labor in other specific matters to which he may be assigned affecting employees of the railroads under federal control.

C. E. CHAMBERS, superintendent of motive power of the Central of New Jersey, has been appointed mechanical assistant to Charles H. Markham, regional director of the Allegheny region of the United States Railroad Administration, with headquarters at Philadelphia, Pa., succeeding J. T. Carroll, resigned, to go to the Baltimore & Ohio.

E. A. CLIFFORD, assistant general purchasing agent of the Atchison, Topeka & Santa Fe at Chicago, has been appointed assistant to the Regional Purchasing Committee for the Central Western region, with headquarters at Chicago.

C. M. FREEMAN, traveling engineer on the Sunset-Central Lines, has been appointed assistant fuel supervisor of the Central Western regional district.

F. W. MARQUISE has been appointed assistant to the manager of the Fuel Conservation Section of the United States Railroad Administration, with office at Washington, D. C., succeeding Edward C. Schmidt, major, Ordnance Department, United States Army, who was temporarily assigned to service with the Fuel Conservation Section, but has returned to the service of the War Department.

OBITUARY

T. W. HEINTZELMAN, formerly general superintendent motive power of the Southern Pacific, died of pneumonia in San Francisco, Cal., on December 11. After serving the Southern Pacific in various capacities for about 28 years he retired on January 1, 1917, on account of ill health.

SUPPLY TRADE NOTES

Joseph T. Ryerson & Son, Chicago, announce the opening of an office in Philadelphia, located in the Widener building.

The Cleveland Milling Machine Company, Cleveland, Ohio, announces that W. P. Sparks is now acting as its representative at Indianapolis, Ind., with office at 316 Terminal building.

The records in the offices of the mechanical department of the El Paso & Southwestern at El Paso, Tex., were lost in a fire on December 5. F. B. Lister has requested the supply trade to send catalogues to replace those destroyed.

George T. Cooke has resigned as eastern sales manager of the Vapor Car Heating Company, Inc., to accept the presidency of the Union Metal Products Company, Chicago, with



G. T. Cooke

office in the Singer building, New York. Mr. Cooke was born in Chicago on May 28, 1883. After receiving a technical and mechanical training he entered the employ of the Pullman Company in 1901 as draftsman. Later he was made chief draftsman of the Calumet repair shops, and subsequently was promoted to chief inspector and finally mechanical inspector. In 1911, he left the Pullman Company to become southern manager for the Chicago Car Heating Company, at Atlanta, Ga., and in 1913, he was transferred to this company's New York office as eastern manager. When the Chicago Car Heating Company and the Standard Heat & Ventilation Company, Inc., were absorbed by the Vapor Car Heating Company, Inc., in 1917, Mr. Cooke was made eastern manager, in charge of sales and mechanical matters in the eastern territory, which position he held until December 1, 1918, the date of his connection with the Union Metal Products Company as president.

H. E. Passmore, formerly with the mechanical department of the New York Central and later production manager of the Marble Cliffs Quarries Company, has been appointed sales representative of the reorganized Grip Nut Company.

Roswell P. Cooley, who has had charge of sales in the southwest, with headquarters at Chicago, has been appointed to succeed Mr. Cooke, and Nelson T. Burns, formerly with the New York Central, has entered the sales department, with headquarters at Chicago.

Cyrus J. Holland has been appointed western representative of the Wine Railway Appliance Company, Toledo, Ohio, with offices at 730 Peoples Gas building, Chicago, succeeding the vice-president, R. F. Tillman, who has been assigned to other duties, with headquarters in Toledo.

The Walworth Manufacturing Company, with general offices at Boston, Mass., and works at Boston and Kewanee, Ill., with branches in New York, Chicago and Seattle, has recently purchased the business of Hunter & Dickson Com-

pany, at 241-247 Arch street, Philadelphia, Pa., and is operating it as one of its branches.

J. K. Mahaffey has been appointed sales manager of the Pittsburgh district with office at Pittsburgh, Pa., for the Edison Storage Battery Co., Orange, N. J. Mr. Mahaffey has been with the Edison Company for the last two years. He was identified for several years with the General Electric Company and a number of other electrical concerns.

Bertram Smith, heretofore district sales manager at Detroit, Mich., has been appointed assistant general sales manager of the Edison Storage Battery Company, with headquarters at the main office, Orange, N. J. Mr. Smith has long been engaged in the storage battery business, having formerly been with the National Battery Company.

George Simons, who has been associated with the Edison Storage Battery Company for the past three years, has been appointed to succeed Bertram Smith as district sales manager at Detroit, Mich. He has had valuable experience in storage battery practice, and was for nine years associated with the National Battery Company, Buffalo, N. Y., and with the United States Light & Heat Corporation.

The Truscon Steel Company, Youngstown, Ohio, which for many years has been manufacturing pressed steel parts principally for use in its own products, announces the expansion of its business into the manufacture of pressed steel parts of all kinds. The work will be handled by the pressed steel department, headed by G. F. Danielson, as manager, who for 25 years has devoted his entire efforts to the manufacture of pressed steel products.

Major William L. Allison, who for the past 18 months has been in active military service, has been honorably discharged from the U. S. Army and has resumed his duties as vice-



Major Allison

president of the American Arch Company. In addition, Major Allison has been elected vice-president in charge of sales of the Locomotive Feed Water Heater Company. Major Allison was one of ten majors graduated from the first training camp at Fort Sheridan, Ill. That he, along with many others, were denied the opportunity of overseas service was a great disappointment to him. Major Allison was born near Salisbury, N. C. He gradu-

ated from the Davis Military School of Winston-Salem, N. C. For over three years he was in government service as deputy marshal. For six years he was employed in various capacities in the Baldwin Locomotive Works, Philadelphia, and in January, 1904, he became mechanical engineer of the Atchison, Topeka & Santa Fe. He resigned from the Santa Fe to become mechanical engineer of the Franklin Railway Supply Company. He was later western sales manager of that company, the Rome Merchant Iron Mills, the Economy Devices Corporation, and general western sales manager of the American Arch Company. He became vice-president of the latter company in January, 1914, which position he still holds in addition to the vice-presidency of the Locomotive Feed Water Heater Company.

The Brown Hoisting Machinery Company, Cleveland, Ohio, announces the following changes in its organization: Harvey H. Brown, chairman of the board of directors; Alexander C. Brown, president; Melvin Pattison, vice-president, general manager and director; Robert G. Clapp, director; John F. Price, director, and Ewen C. Pierce, general manager of sales.

The Independent Pneumatic Tool Company announces the opening of a branch office and service station in Cleveland, Ohio, on December 15. A complete line of Thor pneumatic and electric tools and repair parts will be carried in stock at 1103 Citizens building, under the management of Hayden F. White, who has represented the company in Detroit, Chicago and Milwaukee districts for some years past.

William P. Dalton, formerly for many years chief engineer of the Schenectady plant of the American Locomotive Company, has been appointed assistant manager of the Schenectady works of the General Electric Company. For the last three years Mr. Dalton has been with the Washington Steel & Ordnance Company, engaged in war work. He was graduated from Cornell University in 1890.

John E. Galvin has been elected president of the Ohio Steel Foundry Company of Lima, Ohio. Mr. Galvin has been operating vice-president since the organization of the company in 1907. In 1916 he built a converter and electric foundry at Springfield, Ohio, for the manufacture of small steel castings and later sold it to the Ohio Steel Foundry Company. This plant is now known as the Springfield works of that company.

R. W. Burnett has resigned as master car builder of the Delaware & Hudson to become associated with the Joliet Railway Supply Company as assistant to the general manager, and with the National Car Equipment Company as vice-president, with headquarters at Chicago. Mr. Burnett was born at Farmer City, Ill., in 1868, and in 1890 became connected with the Union Pacific in the car department at Denver, Colo. In 1892 he went to the Pennsylvania as a car inspector at Chicago, and from August, 1892, to July, 1899, was successively foreman and general foreman of the car department of the Lake Shore & Michigan Southern, at Chicago. During the early part of 1900 he was employed as general foreman of the car department of the Long Island, going to the Central Railroad of New Jersey the latter part of the year as general foreman of the car department at Elizabeth, N. J. From 1904 to January, 1907, he was successively assistant master car builder and master car builder of the Erie at Meadville, Pa. On the latter date he went to the Canadian Pacific as assistant master car builder, being made general master car builder in 1909. He left the latter road in November, 1915, to become vice-president of the National Car Equipment Company, returning to railway service on September 1, 1917, as master car builder of the Delaware & Hudson.

L. E. Schumacher, who for the past eight years has been chief inspector of the Westinghouse Electric & Manufactur-

ing Company, at East Pittsburgh, Pa., has been promoted to works manager of the Krantz Manufacturing Company, of Brooklyn, N. Y., the latest subsidiary of the former company. Mr. Schumacher has been with the Westinghouse Electric & Manufacturing Company for 18 years, prior to which he was with the Niagara Falls Power Company. The Krantz concern makes safety switches, panel boards and floor boxes.

S. D. Rosenfeld has been appointed district sales manager of the Franklin Railway Supply Company, Inc., with offices at Houston, Texas. Mr. Rosenfeld has had wide experience



S. D. Rosenfeld

in railroad work and has brought out several inventions that improved locomotive operation. He was born at Lincoln, Neb., and received his early education at that place. Upon leaving college he entered the service of the Chicago & North Western, serving in the machine shop and signal department, and then as fireman and engineer. In 1912, Mr. Rosenfeld resigned as locomotive engineer and entered the service of the Franklin Railway Supply Company as

mechanical representative, which position he held at the time of his recent appointment.

Lieutenant Clarence E. Holborn was instantly killed in an airplane accident at Call Field, Wichita Falls, Tex., on December 3. Lieutenant Holborn, previous to entering the military service, had been in the advertising department of the Hyatt Roller Bearing Company, New York. After leaving school he entered the service of the Simmons-Boardman Publishing Company, publisher of the *Railway Mechanical Engineer*, and for a number of years was connected with it in various capacities in the business and advertising departments.

H. W. Clarke, who until December 15, was connected with the advertising service department of the McGraw-Hill Company at Chicago, has been appointed manager of advertising for the Chicago Pneumatic Tool Company, Chicago. Prior to his connections with the McGraw-Hill publications he spent eight years with the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., part of the time as a member of the sales and publicity departments, and later as western publicity representative, with headquarters at Chicago.

L. J. Kennedy, who for many years has been associated with the Consolidated Railway Electric Lighting & Equipment Company, died in Chicago on October 30. Mr. Kennedy was born in Watertown, N. Y., in 1880, but at an early age moved to Chicago and received his education in the public schools of that city. In 1900 he returned to the east and entered the employ of the Consolidated Railway Electric Lighting & Equipment Company as a machinist in the factory at Shelton, Conn. He was later employed as an inspector, taking care of car lighting equipment on various roads running into Chicago. Mr. Kennedy applied the first electric lighting equipment to the Golden State Limited and also to the Twentieth Century Limited. Later he had charge of the maintenance and operation of the lighting on those



R. W. Burnett

trains. After holding this position for some time, he was placed in charge of the manufacture and sales of the Consolidated company at Chicago, and later, when the Consolidated company discontinued its manufacturing in Chicago, Mr. Kennedy remained in charge of the sales only. In 1913 he left the employ of the Consolidated company to engage in boat building on the North Side of Chicago. Later he went to New Mexico on account of the health of his family and accompanied Pershing's Expedition into Mexico. In 1916, he returned to the employ of the Consolidated as sales engineer, but left the company again in 1917 to once more engage in the boat building business in which he was very successful in completing some large contracts for pontoons for the army.

Dr. Angus Sinclair

Angus Sinclair, D.E., founder and editor-in-chief of Railway and Locomotive Engineering, New York, died at his home in Millburn, N. J., on January 1, 1919, at the age of 78.



Angus Sinclair

Doctor Sinclair was born in Forfar, Scotland. He began his railroad career as a telegraph operator and later was a locomotive engineman on the Scottish Northeastern Railway. He attended evening high school and later for several years was employed in the Customs Department in Montrose, Scotland, and London, England. A love of adventure took him to sea, and, after some service as a marine engineer, he again took up railroad work in America, first

in the service of the Erie, and afterward in the west, where he ran a locomotive on the Burlington, Cedar Rapids & Northern. During this period he attended the chemistry classes of the Iowa State University, making a specialty of water analysis, and was appointed chemist of the railroad, combined with the duties of roundhouse foreman. It was during this period that he first gave serious consideration to the problem of fuel economy and smoke prevention, on which he has since written extensively. In 1883 he joined the editorial staff of the American Machinist, a few years later becoming president of the publishing company. In 1887 the company, desiring to broaden its field, established the Locomotive Engineer, of which the late John A. Hill became editor. A few years later Doctor Sinclair and Mr. Hill bought this paper, now Railway and Locomotive Engineering, and since Mr. Hill's retirement from the partnership in 1897, Doctor Sinclair has been the sole proprietor and editor-in-chief.

In 1908 the faculty of Purdue University, Lafayette, Ind., conferred upon him the honorary degree of Doctor of Engineering. About this time he was appointed special technical instructor in the mechanical department of the Erie Railroad. Doctor Sinclair has also been closely identified with the work of nearly all of the leading engineering societies in America and with some in Europe. He was the senior officer in point of continuous service of the American Railway Master Mechanics' Association, having been treasurer since 1900. Previous to that time he had served as secretary from 1887 to 1896. He was also a member of the Master Car Builders' Association, the American Society of Mechanical Engineers, and was instrumental in the estab-

lishment of the Traveling Engineers' Association, which was organized in his office in 1892. He was a delegate to three International Railway Congresses, at Washington, D. C., St. Louis, Mo., and Berne, Switzerland.

Doctor Sinclair is the author of a number of works on railroad subjects, some of which have become textbooks, including "Locomotive Running and Management," "Combustion in Locomotive Fireboxes," "Firing Locomotives," "Railroad Man's Catechism," "Twentieth Century Locomotives," and "History of the Development of the Locomotive Engine." His first published work, "Locomotive Running and Management," was begun while he was running a locomotive, and was made up entirely from personal observation. It has repeatedly been revised by the author and has passed through 26 editions, the last appearing in 1915. His work on "Firing Locomotives" has been translated into eight languages, including Chinese. In his long and varied career Doctor Sinclair has been a pioneer in the study and development of many practices pertaining to locomotive operation, which have now become well established, and his influence will long be felt in practical railroad operation.

The Whiting Foundry Equipment Company, Harvey, Ill., announces changes that have been made in its organization. The following men have left the company: F. A. Rundle, general superintendent; C. A. Hardy, sales manager; G. R. Brandon and P. A. Dratz, Chicago representatives. Samuel Moore, formerly general manager of the Bond plant of the American Radiator Company, is now general superintendent and the company will be represented in Chicago by George Ristine, formerly with the Pressed Steel Car Company. H. A. Wolcott, formerly with the McMyler Interstate Company, Cleveland, Ohio; E. V. Brown and Walter R. Hans have become members of the company's engineering staff.

Dr. Walter V. Turner

Dr. Walter Victor Turner, manager of engineering of the Westinghouse Air Brake Company, died at the Columbia Hospital, Wilkensburg, Pa., Thursday morning, January 9.



Walter V. Turner

In the death of Doctor Turner the world has lost the greatest air brake expert of the age. Doctor Turner has had a most unique career, having by the fate of destiny entered on a work that has meant so much to American railroading. He was born in Epping Forest, Essex county, England, April 3, 1866. He was in the wool business in that country and came to America in 1888 to develop his education along those lines. He was secretary and manager of

the Lake Ranch Cattle Company, Raton, N. M., in 1893. In 1897 this company failed and Doctor Turner entered the employ of the Atchison, Topeka & Santa Fe as a car repairer. In one month he was made gang foreman and three years later was made chief inspector. Having previously become interested in air brake apparatus through a bad wreck that occurred in the vicinity of his home, he made a very careful study of its intricacies in his new position and it was during the first year of his employ that he developed his first air brake patent. He soon gained a reputation for proficiency in air brakes and was placed in charge of the

air brake instruction car on that road. From general air brake instructor he was promoted to mechanical instructor for the entire system, during this time having sold 22 patents to the Westinghouse Air Brake Company.

At the 1902 convention of the Air Brake Association, which was held in Pittsburgh, Doctor Turner was offered a position with the Westinghouse Air Brake Company, but refused. The offer was repeated again at the 1903 convention and in November of that year arrangements were made between the Air Brake Company and the Santa Fe to loan Doctor Turner to the former. That arrangement was continuously in effect to the time of his death. In 1907 he was made mechanical engineer; in 1910, chief engineer; in 1915, assistant manager, and in 1916, manager of engineering. The first task of Doctor Turner with the Westinghouse Company was to develop the *K* triple valve, of which there are now over 2,000,000 in use. By his untiring energy and ingenuity the art of braking trains has developed by leaps and bounds. He has been granted over 400 patents and a hundred or more are still pending. Among his latest inventions the improved empty and load brake and the electro-pneumatic brake stand out pre-eminently. These made possible an increase of 300 per cent. in the capacity of the New York Subways. Doctor Turner was also an author, among the more important of his books being "Train Control—Its Development and Effect on Transportation Capacity," which was published in two volumes. He was awarded the Longstreth medal in 1911 and the Elliott-Cresson medal in 1912. He was a fellow of the Royal Society of Arts, England, and a member of the American Society of Mechanical Engineers, the American Electric Railway Association, Franklin Institute (Philadelphia), and the Pennsylvania State Chamber of Commerce. The degree, "Doctor of Engineering," was conferred on Doctor Turner by the University of Pittsburgh in 1918.

Doctor Turner's death was the result of complications, among them being enlargement of the heart and Bright's disease. He was injured two or three years ago in an automobile accident, to which he attributed his condition. He had been seriously ill since the middle of November. He leaves besides his widow, a married son and daughter.

William I. Thomson, electrical superintendent of the Safety Car Heating & Lighting Company, died at his home in Newark, N. J., on December 10 of pneumonia. Mr. Thomson was prominent in the field of railway car lighting engineering for many years, and to his efforts are due many important developments in car lighting electrical apparatus. He was born in Newark, N. J., June 26, 1876, graduated from Stevens Institute in the class of 1897, and served as chief machinist on U. S. S. Badger during the Spanish-American war. He was instructor in applied electricity at Stevens Institute from 1897 to 1900, and after working in the electrical construction department of the Manhattan Railway Company, New York, for two years he went to the Safety Car Heating & Lighting Company in 1902.

Fred C. J. Dell has been elected secretary of the National Railway Appliance Company, New York. Mr. Dell has acted in the capacity of secretary to the president of the company for the past two years, previous to which time he was connected with the American Electric Railway Manufacturers' Association as assistant to the secretary-treasurer. He held that position from March, 1911, to May, 1916, at which time he resigned to assume charge of the detail work of the exhibit committee for the 1916 convention of the American Electric Railway Association. In October, 1916, he was elected secretary of the American Electric Railway Manufacturers' Association, which position he still holds. He received his early training in the office of the vice-president and general manager of the Interborough Rapid Transit Company, where he was employed for a period of seven years.

CATALOGUES

PNEUMATIC HAMMER.—A six-page folder describing in detail the construction and operation of the Barr pneumatic high speed hammer has been published by H. Edsill Barr, engineer, Erie, Pa.

TANKS.—A list of the storage, pressure, car tanks, etc., for sale by the Walter A. Zelnicker Supply Company, St. Louis, Mo., with the dimensions and weight of each, is published in bulletin No. 252.

SMALL TOOLS.—Catalogue No. 40, listing taps, dies, screw plates and reamers manufactured by the Greenfield Tap & Die Corporation, Greenfield, Mass., has been issued by this company. It contains 288 pages, in which sizes, prices, dimensions and illustrations are given in convenient form.

TIGHT RIVETS.—The American Flexible Bolt Company, New York, has developed a new type of rivet, known as the American rivet, which is described in bulletin No. 301. It upsets from both ends, and because of this is claimed to make a tight rivet. Reproductions of actual photographs of plates sectioned for the purpose, are shown to illustrate this point.

ROME HOLLOW STAYBOLT IRON.—Bulletin No. 2 of the Rome Iron Mills, Inc., 30 Church street, New York, enumerates the advantages of Rome hollow staybolt iron and bears out a claim of economy with figures comparing the cost of this kind of staybolt iron per engine for the first year and each succeeding year, and the ultimate cost of solid iron, which must be drilled and frequently tested.

RESEATING MACHINES.—Bulletin G-2, recently published by the Lagonda Manufacturing Company, Springfield, Ohio, describes that company's electric, air, steam and water-driven reseating machines for boiler caps and headers. These machines are portable and are especially designed for use on boilers of the Babcock & Wilcox type, using ground joints between caps and cap seats in the headers.

HOISTING MACHINERY.—The equipment manufactured by the Brown Hoisting Machinery Company, Cleveland, Ohio, consisting of trolleys, traveling and portable cranes, electric hoists, etc., is presented in a complete and attractive catalogue, No. D-1919, containing 56 pages, 8½ in. by 11 in., and over 100 illustrations. A large amount of data is also given in tabular form as to prices, dimensions and clearances.

LOCOMOTIVE CONDULETS.—The Crouse-Hinds Company, Syracuse, N. Y., has designed several new condulets for use in electric headlight wiring on steam locomotives, which are listed and illustrated in bulletin No. 1000-1. A plan view and side elevation of a locomotive and tender wired with conduit and condulets, and sectional views of the installation are shown in the catalogue, with a list of the materials required. These drawings are complete insofar as it is possible to make them and they should be of value to anyone charged with the work of installing electric headlights.

FEEDWATER FILTER.—A multiple filtration feedwater filter and grease extractor designed for power plant work and manufactured by the Lagonda Manufacturing Company, Springfield, Ill., is described in some detail in Catalogue R, issued by that company. This is a compact, self-contained unit and the multiple filtration assures thorough cleaning by filtering and re-filtering the water. The filtering element may be easily cleaned and used repeatedly. The catalogue contains a number of illustrations showing the construction of the filter and several installations, as well as a table of dimensions.